

**M&V Summit, Washington, DC
April 21-23rd, 2004
Information Packet**

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Federal M&V Summit Agenda
(April 21st - 23rd, 2004, Washington, DC)
Venue: Hyatt Arlington (Senate Salon B&C)
Meeting Facilitator: Mark Gladstone, Certified Facilitator

1. Wednesday April 21st (12:00 noon to 5:00 pm)

- 12:00 pm – 1:30 pm:** **Luncheon event in Judiciary Hall – Mark Ginsberg, Speaker**
- 1:30 pm – 2:00 pm:** **M&V Summit Kick-off – Senate Salon B&C:** Welcome and introductions (Jose Maniwang and Mark Gladstone)
- 2:00 pm – 2:30 pm:** Industry update - ASHRAE Energy Audit Guidelines, Emissions Quantification, Advanced Metering in LEED for Existing Buildings (Satish Kumar)
- 2:30 pm – 3:00 pm:** Review of recently released M&V tools and documents (Lia Webster)
- 3:00 pm – 3:30 pm:** **Coffee break**
- 3:00 pm – 5:00 pm:** Agency updates (DOE, Navy, Army, Air Force)
- 5:00 pm:** **Adjourn**
- 7:00 pm – 9:00 pm:** **Reception at the hotel (Judiciary Hall)**

2. Thursday April 22nd (8:00 a.m. to 6:00 pm)

- 8:00 am – 8:30 am:** Continental breakfast
- 8:30 am – 10:00 am:** Working group presentations and discussions (Commissioning, M&V Plan and Reporting Integration, O&M Reporting, Advanced Metering, Performance Period Administration)
- 10:00 am – 10:20 am:** **Coffee break**
- 10:20 am – 11:50 am:** Two sequential Working Group discussions (45 minutes each)
- Commissioning (see attached for agenda)
 - M&V Plan and Reporting Integration (see attached for agenda)
- 11:50 am – 12:50 pm:** **Lunch break (Judiciary Hall)**
- 12:50 pm – 3:10 pm:** Three sequential Working Group discussions (45 minutes each)
- O&M Reporting (see attached for agenda)
 - Advanced Metering (see attached for agenda)
 - Performance Period Administration (see attached for agenda)

3:10 pm – 3:30 pm: Coffee break

3:30 pm – 5:00 pm: Successful M&V Case Studies:

- a) M&V in a Combined Heat & Power (CHP) project (John Shonder, ORNL)
- b) M&V of a CHP project – Case Study (Mustafa Abbas, Sempra Energy Solutions)
- c) Example of good M&V w/out metering (Venkat Kumar, Johnson Controls)

5:00 pm – 6:00 pm: Working Group breakout meetings, as needed

6: 00 pm: Adjourn

7: 00 pm – 10:00 pm: **Social Event : Capital City Brewing Company**
2700 S. Quincy St., Arlington, VA.
<http://www.capcitybrew.com/arlington.htm>, Phone: 703-578-3888

3. Friday April 23rd (7:30 a.m. to 12:00 p.m.)

7:30 am – 8:30 am: Working breakfast (Working Group breakout meetings, as needed)

8:30 am –9:30 am: Report out from working group meetings; revise working group goals (Working Group leads)

9:30 am 10:30 am: Discussions to identify hot topics

10:30 am – 10:50 am: Coffee break

10:50 am – 12:00 pm: Summarizing M&V summit: (Dale Sartor)
List action items with priorities (Dale Sartor)
Identify topics for Board consideration
Collect Feedback Form
Decide dates for the next M&V summit

12:00 pm: Adjourn M&V Summit

12:00 pm – 3:00 pm: Federal ESPC Steering Committee Meeting – The Gallery
(working lunch)

Working Group Agenda Topics for the M&V Summit Discussion

April 22, 2004

1. Commissioning Working Group

- Review Cx Guidance Document
- Review of changes to ECM Commissioning Additions
- Strategize - Guidance to customers
- Review of Status Report Actions
 - Cx Report Requirements
 - Training
 - IDIQ Contract input
 - Generic Cx Guide for agency contracts

2. M&V Plan and Reporting Working Group

- Coordinate plan & report content related to Cx WG
- Coordinate plan & report content related to O&M Reporting WG
- Discuss Agency's annual ESPC reporting requirements to DOE/congress. Should the Annual Report be leveraged to include this information?

3. O&M Reporting Working Group

- Coordinate O&M Working Group activities with other working groups (esp. Cx and M&V Plan and Reporting Integration).
- Seek assistance of agency reps in getting input on the O&M checklists being prepared by the WG.
- Seek assistance of other ESCOs in contributing O&M checklists to the Working Group.

4. Advanced Metering Working Group

- Develop outline and milestones for the metering guidance document.
- Share case studies of applications of advanced metering at federal facilities: Resource efficiency managers at the Navy's San Diego area installations, Denver Federal Center, and Fort Bragg.

5. Performance Period Administration Working Group

- Review the full package
- Discuss incorporating comments generated during presentation
- Discuss how to incorporate outputs from other WGs (O&M, Cx, Annual Reporting, etc)
- Discuss future direction of PPA WG.

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April 21st – 23rd, 2004

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Federal M&V Summit
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Wednesday, April 21

1. Kick-off Introductions and Welcome (Gladstone & Maniwang)
2. Overview of M&V Team (Webster)
3. Industry update (Kumar)
 - Emission credits (Canada, Netherlands, and PCF are biggest players)
 - Negawatt trading – using energy savings for emission credits
 - a. Common activities with ESPC (e.g. M&V)
 - b. San Diego VA/ESCO project utilized emission credit in deal
 - c. Navy has looked at and may be future opportunity, however problems with giving out credits forfeit future use when needed for growth
 - ASHRAE Audit Guidelines
 - a. Define terms and good procedures for various levels of audits
 - b. Expected this year
 - LEED credit for Advanced Metering in existing buildings
 - Changes to LEED new construction M&V credit
4. Agency Updates
 - DOE (Sartor and Strajnic)
 - a. Reorganization of Federal ESPC Board and QA&I Team (formally DOD/DOE Steering Committee and M&V Team)
 - b. Report on Capital Hill activity (reauthorization)
 - i. Scoring – assigns “cost” to ESPC legislation (causes “budget” problems despite cost coming from savings)
 - c. Goal – Audit Proof program
 - Navy (Matsui)
 - a. Program update
 - i. 17 projects (over \$100M on hold pending legislation)
 - ii. Taking advantage of time to implement program improvements
 - b. Adoption of guidelines/templates
 - i. Spec for plan and report formats (per Team recommendations)
 - ii. Going to electronic documents to improve documentation
 - c. Documentation Matrix
 - i. Based on WG Documentation Structure
 - ii. Added tracking table
 - d. Integrity Issues
 - i. Estimated savings vs. actual, vs. guaranteed
 - ii. Transition to standard formats for M&V documents
 - iii. GAO Audit – looked at three projects
 - iv. Standardization and help from ESCO’s critical
 - e. Possible joint PF meeting
 - Army (Williams)
 - a. ESPC is invaluable to the Army
 - b. No new task orders until legislation passes
 - c. May stop work on projects in progress

- d. ESPC Policy draft adopts, with minimal changes, M&V Team document outlines
 - i. Past audit concerns (e.g. M&V) being addressed
 - ii. Document outlines included in Appendix to facilitate use and updates
 - e. Developing overall energy strategy (incl. ESPC)
 - i. Completion expected this year
- Air Force (Cross)
 - a. Significant number of DO's in 03
 - b. Impact of Sunset Provision
 - i. Proceeding with existing contracts and issuing orders (under AF contract)
 - ii. Navy can use, likely can't be used by others
 - iii. Contract capacity expired in Western region
 - c. M&V Prototype development
 - i. Parallel effort to WG activity
 - ii. Lighting Template in summit workbook
 - iii. Six completed and on web, many others in progress and close to release
 - iv. One project with four ECP's underway – possible case study next summit: Altus AF Oklahoma with Honeywell
- **Action: Post presentations and notes (including those not in workbook) on web at <http://www.dc.lbl.gov/mv/>**

Thursday April 22

Working Group Presentations/discussions

1. Commissioning (Dunnivant)
 - a. **Action: Review Cx Guidance Document and send to Steve Dunnivant)**
2. M&V Plan and Reporting Integration (Webster)
 - a. Revised outlines completed (in draft); to be included in SuperESPC IDIQ update in approx. 1 month; living document, may try to include current and point to web site for latest draft
 - b. Example documents to be developed (or samples made available)
 - c. **Action: Review Draft outlines**
 - d. How maintain consistency?
 - i. Integration with Air Force? (Revisit?)
 1. Look at testing both the joint outlines and Air Force docs then revisit
 - e. **Action: Link to Air Force ECM specific templates (on M&V Web site)**
3. O&M Reporting (Kumar)
 - a. **Action: Consider use of FEMP O&M Checklists from FEMP O&M Best Practices doc**
 - i. Checklist was distributed to working group
 - b. Issue: Coordination with other working groups (afternoon task)
 - c. Issue: Where/how will checklists be used?
4. Advanced Metering (Hunt)
 - a. Product (meters and software) information desirable, but difficult to avoid product endorsements
 - i. **Action: Provide web link to LBNL product info site**
 - b. Issue: Data management/documentation - integration into project

- c. Issue: How much accuracy is needed – trade-off between cost and accuracy (what are real needs)
- d. Issue: Sensor calibration and maintenance
- e. FEMP will utilize results of working group into anticipated Guidance document (not ESPC specific)
- 5. Performance Period Administration (Howard)
 - a. Concern that Sites takes O&M responsibility (with track record of less than optimum performance); O&M piece to be from O&M WG
 - b. Relates to other Team activity – integration goal
 - c. PF Responsible for assembly of hardcopy “notebook” provided to site at project acceptance, then updated by facility annually (with annual reports)
 - d. Action: Needs to be integrated with agency binder (Delmastro)**
 - i. agency binder may be more generic – outlines process & tools
 - e. Issue: Who assembles on non-project facilitated projects – all Super’s may have PF required, could be Agency person
 - f. Put requirement of Performance Period Notebook on project checklist to make responsibility of PF
 - g. PF tasks and expectations should be documented for all projects (irrespective of who provides project facilitation)

Working Group meetings (sequential meetings with the whole team to assure integration)

- 1. Commissioning WG (Dunnivant and Dahle)
 - a. Flowchart
 - b. Cx Guidance Document
 - i. Objective: short readable intro (living document)
 - c. Cx Roles & Responsibilities
 - d. Action: Review flowchart, guidance document, roles & responsibility, and IDIQ modification(s) and provide comments to Dunnivant or Dahle by May 7**

Action: If contract (IDIQ) calls for use of latest documents referenced on a website, most recent document at time of delivery order governs. Therefore, website must maintain older document versions (with dates). Alternatively, DO RFP could include entire text of referenced documents/outlines.

- 2. Plan and Reporting WG (Webster)
 - a. Need to clarify:
 - i. Type of commissioning
 - ii. Where should ECM Specific details go
 - iii. Relation between Cx and M&V still confusing; 3.6.2 covers Cx – here or in preliminary Cx plan? this is the level of detail required.
 - iv. Functional vs. performance requirements and remedy if not meeting those requirements ;impact on payments/guarantee should be clarified.
 - v. O&M covered in 3.7.8 – needs to reference checklists which are to be developed
 - vi. Language of outline document – guidance or requirement? see tone of “recommended” vs “required”
 - b. Action: Need to address warrantee issues (where???)**
 - c. Action: Comments ASAP to facilitate pending changes to IDIQ**
- 3. O&M Reporting (Kumar)

- a. ESCO prepares O&M Plan and checklists (process for documentation), performing entity implements and documents (e.g. fills in checklist), ESCO summarizes documentation in Annual Report and alerts government relative to deficiencies.
 - b. May want to limit the number of example ECM level checklists developed by the Working Group (at what level of detail?), then look for common elements and develop high-level guidance. Provide questions to consider in developing checklists. Actual checklists will be project specific.
 - c. Need to develop process/tools for archiving O&M procedures and results
 - d. Need to address warrantee issues
 - e. **Action: joint meeting of Report Integration and O&M Reporting working group**
 - f. DOE allows the ESCO to step in if maintenance is not done, perform the maintenance and charge the government (consider getting “quote” up front.
 - g. Checklists help to educate all parties on expectations and clarify responsibilities.
 - h. WG to provide guidance on O&M reporting and how that reporting relates to the annual reporting requirements
4. Advanced Metering (Hunt)
- a. Guidance document content
 - i. Discussed
 - ii. DOD has guidance document underway (first draft complete)
 - 1. Metering alone costs a lot of \$ and doesn’t save energy (but leads to savings)
 - 2. If an estimated savings is stipulated (e.g. 1-2%), life-cycle-cost evaluation can be made and investment justified
 - 3. How can advanced metering be developed as a stand-alone ECM under an ESPC? Can bundle with other ECM’s.
 - b. Metering can be used for cost allocation, M&V (baselining), continuous commissioning, energy awareness
 - c. Case Studies
 - i. Denver Fed Center – Most (90%) square footage metered (gas and electric), ESCO provided meters and analysis, guaranteed savings (with first year being the base year), with agency responsible for implementing interventions.
5. Performance Period Administration (Howard)
- a. Review of Roles and Responsibility Matrix and Risk Management Matrix and consider inclusion of responsibility for persistence
 - b. Next steps: field test
6. CHP Overview (Shonder)
- a. Consider putting guidance, as it becomes available, onto M&V web site.
7. CHP Case Study (Abbas)
- a. Efficiency guaranteed, load stipulated by site (take or pay)
 - b. Availability assumed 100%
 - c. Operation of generator depends on best value (turned off when electric prices and thermal loads low)
8. M&V w/out metering (Kumar & Piest)
- a. Presentation states “proprietary info” however speakers OK’d putting on web

Friday April 23

Working Group Report-Outs

1. Commissioning
 - a. **Action: Comments on Guideline in binder to Dunnivant by April 30**
 - b. **Action: Comments on IDIQ mods to Dahle by May 7**
2. O&M Reporting
 - a. **Action: Provide input to IDIQ mods**
 - b. **Action: Review Risk & Responsibility matrix for O&M mods**
 - c. Example checklists to be made available (for most common ECMs)
3. Advanced Metering
 - a. Sub-groups will be formed
 - b. FEMP O&M material/resources to be heavily used
 - c. Build on EMCS, add meters over time with \$ from energy savings
 - d. Can we stipulate saving (no, or we need direction)?
4. Plan and Report Integration
 - a. Getting together with other working groups for lots of activity in short time frame
 - b. Need to resolve issue of how to set requirements yet maintain flexibility for changes/improvements (e.g. appendix)
 - c. Need to clarify terminology and be consistent
5. Performance Period Adm.
 - a. Include the "acceptance sign off sheet" in the package.
 - b. Include a sample of the package in the "Agency Project Binder".
 - c. Include the requirement to make a PPA package in the contractual documents. Reporting Requirements Checklist and maybe Risk Responsibility Matrix as part of a section addressing Continuity of Savings
 - d. Get test packages made for three or four projects this summer.

IDIQ Modification implementation (Dahle)

1. Preparing mods for implementation later this year
2. **Action: draft red-line document To be sent out. Comments by May 7**
3. Telecon for discussion will be scheduled May 14
4. Draft to Golden by May 18
5. See handout for mod description
6. **Action: Check versions of Risk and Responsibility Matrix for latest mods**
7. **Action: Produce "generic" Risk and Responsibility Matrix for use by building owners other than fed agencies (not for purposes of IDIQ)**

Hot ESPC Topics that could be addressed by Federal Quality Assurance and Improvement Team

Topic	Priority
1. Need for a tech resource manager/REM during perf. period Funding the government's project support costs (e.g. on-site project management PF recruitment, training and QA (minimum qualifications, potential certification Need for project facilitation – should be requirement	21
2. Revisit Risk Management Matrix and Roles and Responsibility Matrix, and how to incorporate them into IDIQ (may be action item rather than WG)	0
3. Address warranty impacts of O&M – ½ year CHECK-IN?	0
4. Lack of feedback and approval from CO/COR of submittals	1

(including reports)	
5. Ways of increasing use of renewable and new technologies	17
6. Input to repurchase of IDIQ's (expand ESCO pool)	0
7. Explore Alternative financing to reduce cost (of financing) and increase sources of financing	0
8. Increase granularity (e.g. monthly) of data and reduce use of stipulation	10
9. O&M Savings used to finance ESPC (Policy, auditor's perspective/red flags, develop criteria/guidelines incl baseline)	9
10. Need for risk analysis (how to approach)	0
11. Leveraging need for security assessment to Retro commissioning	3
12. Super ESPC "lite" for smaller facilities (simplify)	14
13. Replace FEMP 2.2 with IPMVP and supplemental guidance	7
14. Financial implication of changes (possible agenda item)	1
15.	

Priority Topics to take to Federal ESPC Board (list with names of initial volunteers including author to write proposed objective and deliverables)

<p>1. Need for a tech resource manager/REM during perf. period Funding the government's project support costs (e.g. on-site project management). PF should be requirement. Action: Consider at Board</p> <p>Scope, Training and QA (minimum qualifications, potential certification Need for project facilitation – Action: Recommend as WG Product: Scope document for one or more "positions"</p> <ul style="list-style-type: none"> On-site personnel Remote (current PF activity) 	21
<p>2. Methods of increasing use of renewable and new technologies Action: Recommend WG Scope/product: Survey of products Product evaluation Collect info resources ID Incentives</p>	17
<p>3. Super ESPC "lite" for smaller facilities (simplify) Action: consider pilot WG to address issues and develop pilot/guidance</p>	15

4. Increase granularity (e.g. monthly) of data and reduce use of stipulation (GAO audits raising concerns of taking annual data and dividing by 12) Action: WG/effort to develop assess practicality then educate auditors or develop possible approaches (e.g. contract language to specify monthly savings) Action: Jose to get us more information Action: Educate auditors invite to special briefing (perhaps covering broader issues)	10
5. O&M Savings used to finance ESPC (Policy, auditor's perspective/red flags, develop criteria/guidelines incl baseline) Action: Consider as follow-up activity of current O&M WG (may change membership)	10
6. Replace FEMP 2.2 with IPMVP and supplemental guidance Action: DOE to consider as FY 05 activity Consider as part of IDIQ mod? (NO) Keep flexibility for non-continuous measurement Consider other standards such as ASHRAE G14	7

Summary of Meeting and Review of Action Items

1. Review notes (Sartor)
2. Summarize new Federal ESPC Board and Quality Assurance and Improvement Team
 - o Team patterned after structure of M&V Team – thanks to Quinn
 - o Set of Technical Working Groups forms informal Sub-Team (us)
- Thanks Mark, Jane, Doug, everyone – open and honest discussion

E-mail survey:

1. Are we (Federal M&V Team) making good progress?
Not much = 1
Absolutely = 5
2. What's Missing, what can be improved to raise score:

Feedback Form (more feedback would be even more appreciated)

Next Meeting

- Straw proposal: November/December San Diego

Supplementary notes from David Hunt (Advanced Metering WG discussion)

This message summarizes the highlights from the M&V Summit as they pertain to the Advanced Metering Working Group (AMWG) and discusses potential next steps. Please note that at the end of this message I ask for your feedback on how this working group should proceed.

A copy of the Thursday AMWG presentation is attached. In short, comments received seemed to be in agreement with the action path focusing on guidance for sites and identifying strategies. My notes do not show significant comments, but others in attendance are free to share their observations.

Thursday afternoon AMWG discussion 1:

Topic 1 - DoD metering policy: Per Jose Maniwang from the Navy, the DoD metering policy is in final draft. Hope is to have this policy final in a month or so. AMWG will track this policy and coordinate outcome with group products. Notes from discussion -- estimate cost to fully meter DoD is \$2B to \$3B;

DoD wants water and steam included; DoD agrees that positive savings result from metering, but life-cycle costing must be used to justify. Question raised if savings from metering can be stipulated but was not resolved. Jose suggested the approach of bundling meters as part of ESPC project be considered.

Topic 2 -- Develop outline and milestones for the guidance document: Listed below are the items suggested (in order received) during the discussion for inclusion in the guidance document. The discussion did not get into overall format, message, or target, all of which must be addressed prior to developing a first draft. Comments by some seemed to lean in favor of a more technical document, while other comments favored a (shorter) more top-level document with references allowing readers to drill down (I prefer this approach).

Content

- a. Legislated or agency requirements
- b. Meter maintenance requirements
- c. Opportunities and benefits – best and most common
- d. Define advanced metering, metering, automated metering, etc.
- e. Overview with general descriptions (expand beyond electrical)
- f. Information cycle
- g. Price ranges
- h. Data requirements
- i. How to avoid paralysis by analysis
- j. Objective – actionable items
- k. Reporting savings
- l. Case studies
- m. Roles and responsibilities
- n. References
- o. Marketing plan for facility

General plan and milestones are 1) coordinate with FEMP O&M program in May on their development of metering materials, 2) interim draft guidance document in July, and 3) final draft guidance in September

Topic 3 -- Case Studies: Phil Voss discussed the Denver Federal Center ESPC delivery order where metering is being applied in an on-going commissioning-like manner. Phil is developing a write-up that will be distributed to the AMWG once it is completed. It appears that JCI analyzes the data from the meters installed under the DO and makes recommendations on corrective measures to GSA. GSA is responsible for actions. Another case study discussed at length was the Fort Bragg ESPC effort where metering used by an assessment primarily to support electric and gas purchasing, but are also used to identify new projects. Further discussion in the small breakout centered on the concept of seeding initial installations of advanced metering by bundling into initial project and installing additional meters in subsequent task orders out of generated savings. Raised (again) was the question of being able to stipulate savings for (certain) advanced meter applications. It was agreed that the lack of data of savings resulting from meter application is likely a barrier to this approach, but the AMWG should continue to explore.

Notes from the overall Summit are to be posted on the LBNL M&V website at <http://www.dc.lbl.gov/mv/>.

What are the next steps for the AMWG? My suggestion is to split the working group into two-sub groups with one addressing the introductory information piece and the other developing approaches to installing advanced metering via alternative financing. Individuals would be free to participate in either or both groups, I would just need to know which of the groups you want to work with. **Please let me know your thoughts about this new approach by May 5.** I will wait until after May 6 before I suggest new meeting dates.

Overview of M&V Team and Existing Tools

Lia Webster & Dale Sartor
Washington DC M&V Summit
April 22, 2004

Overview of M&V Team:

- This is the 6th Federal M&V Summit since October 2001
- Participants include DOE, DOD, federal agencies, ESCO partners, others involved with Federal ESPCs
- Currently 5 active working groups:
 - Commissioning WG
 - M&V Plan & Reporting Integration WG
 - Advanced Metering WG
 - O&M Reporting WG
 - Performance Period Administration WG

6 working groups have completed their deliverables:

- M&V Planning WG
 - *M&V Planning Tool*
- M&V Training WG
 - M&V course
- Retro-Commissioning WG
 - *Introduction to Including Retro-Commissioning in Federal Energy Saving Performance Contracts*
 - *Example Retro-Commissioning Scope of Work To Include Services as Part of Super ESPC Detailed Energy Survey*
- Annual Reporting WG
 - *Annual Report Outline*
- M&V Plan Outline WG
 - *M&V plan Outline*
 - *Post-installation Report Outline*
- Project Documentation WG
 - *Draft project Documentation Structure*

Federal M&V Team Resources:

M&V Team keeps tools & materials in 2 locations:

1) Federal M&V Team website:

<http://www.dc.lbl.gov/mv/>

2) LBNL's A-Team website:

<http://ateam.lbl.gov/mv/>

Federal M&V Team website

<http://www.dc.lbl.gov/mv/>

Web site is kept updated with:

- Contact information for all participants
- Working Group Information:
 - Active and completed WGs
 - WG status reports, goals, deliverables, participants, meeting minutes, interim / final WG deliverables
- Information on M&V Summits
- “Products” page links to LBNL A-Team site

LBNL's A-Team website:

<http://ateam.lbl.gov/mv/>

“Applications Team” (A-Team) Measurement & Verification Documents (see printout of website):

- Key M&V Documents
 - M&V guidelines, training curriculum, finished WG products
- Draft M&V Documents
 - Draft products
- Background Documents
 - Related items on topics such as commissioning, baselines, stipulations
- Links
 - FEMP Super ESPC home page, Defense Energy Support Center, and Dept. of Navy Performance Contracting

Measurement & Verification Documents

[Key Documents](#)
[Draft Documents](#)
[Background Documents](#)
[Links](#)
[IPMVP](#)

The following resources will help organizations implement an M&V program. The materials range from implementation guidelines to checklists and other resources. For more information, view the [FEMP Super ESPC Homepage](#).

Key M&V Documents

[FEMP M & V Guide](#)
[Version 2.2](#)
August 2000

This document provides guidelines and methods for measuring and verifying energy and cost savings associated with Federal agency performance contracts.
(PDF 2.47 MB, 340 pages)

[Detailed Guidelines for
FEMP M&V Option A](#)
May 29, 2002 (.doc)

A detailed guide to applying Option A M&V protocols.

[Option A Detailed
Guidelines](#)
May 29, 2002 (.pdf)

Same file as above in PDF format.

[M&V Resources and
Training Opportunities](#)
Revision 5
June 16, 2003

This frequently updated web page provides an extensive collection of resources, describing tools indicative of those available to help users apply M&V protocols. Resources detailed include current M&V training classes, guidelines from utility, state, and national organizations, case studies, equipment such as data loggers, as well as software tools.

[FEMP 1/2 Day M&V
Training Course](#)
July 23, 2003

These Powerpoint™ presentations are used during a half-day measurement and verification training course which is now offered in conjunction with the FEMP ESPC Delivery Order Workshops.

[Complete Set](#)
(584 KB .zip file)

[Part 1](#)
(69 KB .ppt file)

[Part 2](#)
(390 KB .ppt file)

[Part 3](#)
(436 KB .ppt file)

[Part 4](#)
(121 KB .ppt file)

Responsibility Matrix <i>Version included in IDIQ (.doc)</i> Responsibility Matrix <i>Version included in IDIQ (.pdf)</i>	<p>This two-page summary describes typical financial and operational responsibilities (e.g., energy costs, operating hours) and their impacts on ESPC contracts. There are two blank columns to be filled in by the user.</p> <p>Same file as above in PDF format.</p>
Annual Report Outline <i>May 19,2003 (.doc)</i>	<p>This outline details a comprehensive reporting format for annual measurement & verification (M&V) reports for ESPC projects. In addition to providing place holders for M&V activities, this outline includes reporting on verification of performance, operations, and maintenance activities.</p>
M&V Review Checklist <i>January 2004</i>	<p>Use these checklists to help ensure adequate content of M&V plans, Post-Installation Reports, and Annual Reports.</p>
M&V Planning Tool <i>June 17, 2003</i>	<p>The goal of the M&V Planning Tool is to provide a framework that will help in the development of a technically rigorous M&V plan. The Tool helps by identifying M&V specific issues at an early stage of project development and by assessing risks and the cost implications of different approaches. M&V Planning Tool is provided as one zipped file which contains one Word file (to be read first) and two Powerpoint files.</p>
Introduction to M&V for Super ESPC Projects	<p>This document provides an overview of why and how M&V is conducted in Super ESPC projects. Topics include allocating project risk using M&V, overview of steps to verify savings, and key M&V submittals encountered in Super ESPC projects.</p>

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Draft M & V Documents	
Draft Renewable Energy Guide <i>October 2000</i>	<p>Proposed revision to Chapter 35 Renewable Energy Technologies, of the FEMP Measurement and Verification Guidelines for Federal Energy Projects. Alternatively, this may be published as a separate guide.</p>
Draft M&V Plan Outline	<p>Under development by a working group of the Federal M&V Team, this draft template for an M&V plan is being developed for use on all Federal ESPC projects.</p>
Draft Post-Installation M&V Report Outline	<p>This template covers installation verification and has been developed by the Federal M&V Team for use on Federal ESPC projects.</p>
Including Retro-Commissioning in Federal Energy Saving Performance Contracts Example Retro-Commissioning Scope of Work	<p>Prepared by the FEMP M&V Team, the first document provides an overview of including retro-commissioning with a performance contract.</p> <p>This document is a step-by-step scope of work which can be used to incorporate retro-commissioning services into a Super ESPC project.</p>

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Background Documents

<u>Continuous Commissioning Guidebook</u>	Continuous Commissioning Guidebook for Federal Energy Managers provides specific details on optimizing commercial building systems through metering various types of systems, setting performance benchmarks, and calculating energy savings. This guide was developed for FEMP by Texas A&M and is dated October 2002.
<u>M & V for Operations and Maintenance Technical Note</u> <i>April 27, 1998</i>	This four-page technical note summarizes issues associated with implementing M&V protocols on operations and maintenance improvements.
<u>Background Paper on M&V for O&M</u>	This document identifies issues and approaches for measuring and verifying (M&V) savings associated with improvements in operations and maintenance (O&M) of commercial and institutional buildings.
<u>Application of FEMP M&V Guidelines on Super ESPC Projects: Observations and Recommendations</u> <i>May 2000</i> <u>Technical Appendix</u>	This report describes 7 Super ESPC projects in the Western Region, noting common practices and including 11 recommendations for improving M & V planning and implementation.
<u>DOE ESPC Procedures and Methods</u>	Excerpts from the Energy Policy Act of 1992 related to ESPC and M&V, 10 CFR Part 436.
<u>Advanced Utility Metering</u>	Overview of options in metering technology, system architecture, implementation & relative costs. <i>(published by NREL in 2002)</i>
<u>Baseline Adjustments</u>	Issue paper on Baseline Adjustments (1993)
<u>M & V Team Charge</u> <i>January 2004</i>	Describes the FEMP National M&V Team, its members, goals and expectations
<u>M&V Value Tool Specifications</u> <i>May 19, 2001</i> <u>Spreadsheet of Example Projects</u>	<p>This file contains functional specifications for an alpha version of a tool that helps users calculate energy savings, savings uncertainty, and M&V costs for energy end-use equipment projects. It is a planning tool to develop and compare different M&V activities based on uncertainty and cost, and help the user either select the most cost-effective M&V plan for their project, or apply limited resources where they will be most effective.</p> <p>The spreadsheet contains two example projects that use the methodology contained in the specifications, and are provided for developers to check the Tool's output.</p>
<u>M&V Case Study</u> <i>November 2001</i>	M&V Case Study Power Point Presentation

<u>Practical Guide for Commissioning Existing Buildings</u>	A guide of almost 150 pages prepared by the staff of Portland Energy Conservation, Inc. and Oak Ridge National Laboratory that covers the benefits and how-to's of retro-commissioning projects. Individual guide sections are available in WordPerfect 6/7/8/9 file format (use the link, left).
<u>Practical Guide for Commissioning Existing Buildings</u>	This link downloads the entire retro-commissioning guide in PDF format, 380 KB.
<u>Commissioning In Energy Performance Contracts</u> <i>April 2000</i>	This paper investigates issues related to Energy Savings Performance Contracts (PCs). It provides specific guidance on how to incorporate and integrate commissioning into various types of PC contracts and for various types of buildings and equipment. The information in this paper can assist both owners and contractors in planning and conducting appropriate and efficient commissioning in their PC projects.
<u>Proper Use of Stipulations in M&V</u>	This FEMP Focus article provides an overview of the proper use of Option A M&V methods, as detailed in <i>Detailed Guidelines for FEMP M&V Option A</i> .

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Links	
<u>Air Force ESPC</u>	Air Force Civil Engineering Support Agency - Energy Savings Performance Contracts - Details contract vehicles, training and publications available.
<u>Army ESPC</u>	Guidance and tools on Energy Savings Performance Contracting from Facilities and Housing Directorate - Utilities and US Army Engineering and Support Center, Huntsville.
<u>Defense Energy Support</u>	General Information on ESPC and support services through Defense Energy Support - Energy Conservation Branch.
<u>International Performance Measurement and Verification Protocol (IPMVP)</u>	An informational site providing an overview of current M&V best practices available for verifying results of energy efficiency, water efficiency, and renewable energy projects in commercial and industrial facilities. The web site contains information about MVP, why is M&V important, who develops and sponsors it, and provides links for downloading electronic copies of the protocol or requesting hard copies of the MVP.
<u>Commissioning and O&M Resources</u>	Portland Energy Conservation Inc.'s page for Commissioning and O&M Resources. The page contains links to documents and organizations related to building commissioning and operation and maintenance.
<u>FEMP Super ESPC homepage</u>	FEMP's home page for ESPCs. Includes links to tools, guides, and contracts.
<u>Navy/Marines ESPC</u>	Dept. of the Navy - Navy energy saving performance contracting site provides details on available contract vehicles, training, and publications.
<u>M&V Instructional Tool</u>	The Monitoring and Verification (M&V) Instructional Tool was developed by Pacific Northwest National Lab (PNNL) to provide basic information on M&V with the ability to drill down to get more detail. The tool is presented in a Windows Help format as a compiled help file (CHM), like help files in Microsoft Windows.

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NAVY ESPC TEAM M&V UPDATE

Darryl Matsui
Navy ESPC Team Lead
Naval Facilities Engineering Service Center
Port Hueneme, CA

4/28/2004

Presentation Topics



- **Navy Program Update**
- **Adopted M&V Guidance/Templates**
- **Navy Project Documentation Matrix**
- **Program/Project Integrity Issues**

Navy Program Update



- **Continue to wait for new ESPC Legislation**
- **Navy ESPC Program remains on hold**
 - 17 potential ESPC projects awaiting new legislation
- **Currently only considering in scope modifications where additional work improves existing ECM's**
- **Navy ESPC Team Improvements**
 - Improving documentation collection and storage process
 - Updating and developing new SOP's for PF and CO use
 - Improving M&V review process
 - Adopting completed M&V guidance/templates

Adopted M&V Guidance/Templates



- **Navy DORFP modification**
 - Section C.4.2, has been modified to include:
“Specify that contractor shall provide an M&V Plan, Post-Installation M&V Report and Annual Report in adherence with the format of the DOE outline documents specified in Section J, List of Attachments”.
 - Also, included in Section C.4.2:
“Specify that annual report shall be provided in electronic PDF format on CD”.
- **Navy Project Documentation Matrix**
 - Adopted customized Project Documentation Structure

Navy Project Documentation Matrix



- **Based on the Project Documentation Structure developed by the Project Documentation Working Group**
 - **Modified for Navy ESPC Team use**
 - **Navy Project Documentation Matrix will be used by PF's to:**
 - **Track key project documentation**
 - **Track who holds, when received, and in what format project documentation are in**
- * Intent is to ensure that all key project documentation can be accounted for and that the Matrix can be shared between PF's, CO's, the activity, future PF's, etc.*

Navy Project Documentation Matrix



Project Documentation Matrix				Last Update				
Core documents through project life								
General Project Information								
Contract Source #								
Delivery Order #								
Base/Location								
Site Tech Representative		Phone #						
Region								
Region POC		Phone #						
Claim/CNI/MCHQ								
Claim/CNI/MCHQ POC		Phone #						
Contracting Vehicle								
ESCO								
ESCO PD		Phone #						
Navy ESPC PF		Phone #						
Navy ESPC CO		Phone #						
Project Description								
Yellow highlight indicates items required to be held by CO								
		Comments	Documents Held By				Media	Received
			CO	PF	Site	Other	(H, CD, E, NAFI)	Date
1. Pre-Award documents								
a.	Site Data – Government generated							
	i. Site Data Package							
	ii. Audit Studies/Surveys							
	iii. MOA							
	iv. Other							
b.	IP/Phase I documents							
	i. Initial Proposal (IP)/Phase I approval notification							
	ii. IP							
	iii. IP Response to comments, mtg minutes, etc.							
	iv. Incentive Funding Spreadsheet Life Cycle Cost Analysis							
	v. Other							
c.	Notice of intent (NOI) to award							
d.	Congressional notification letter, if applicable (project > \$10 million)							
e.	DO RFP/SOW							
	i. Terms and Conditions							
	ii. Attachments							
	iii. Other							

Program/Project Integrity Issues



- **M&V AVR's -**

- **“Estimated savings versus Actual savings.” Believe AVR's should focus on “Guaranteed savings versus Actual savings”**
 - The comparison of estimated versus actual raised flag with GAO auditors
 - Viewed difference of estimated and guaranteed savings as amount that should be returned to the US Treasury

- **Transition to standard format M&V documents**

- **Transition will help Navy ESPC Team develop an efficient M&V review process, reduce review time and ultimately free up time to continue to develop new DO's.**
- **Hope ESCO's will work with Navy ESPC Team to transition Post Installation Reports and AVR's for awarded projects.**

Navy ESPC Team Points of Contact



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Headquarters U.S. Air Force

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AF ESPC UPDATE



**J. Michael Cross, PE, CEM
AFCESA Energy Support Team
Northrop Grumman Mission Systems**

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Headquarters U.S. Air Force

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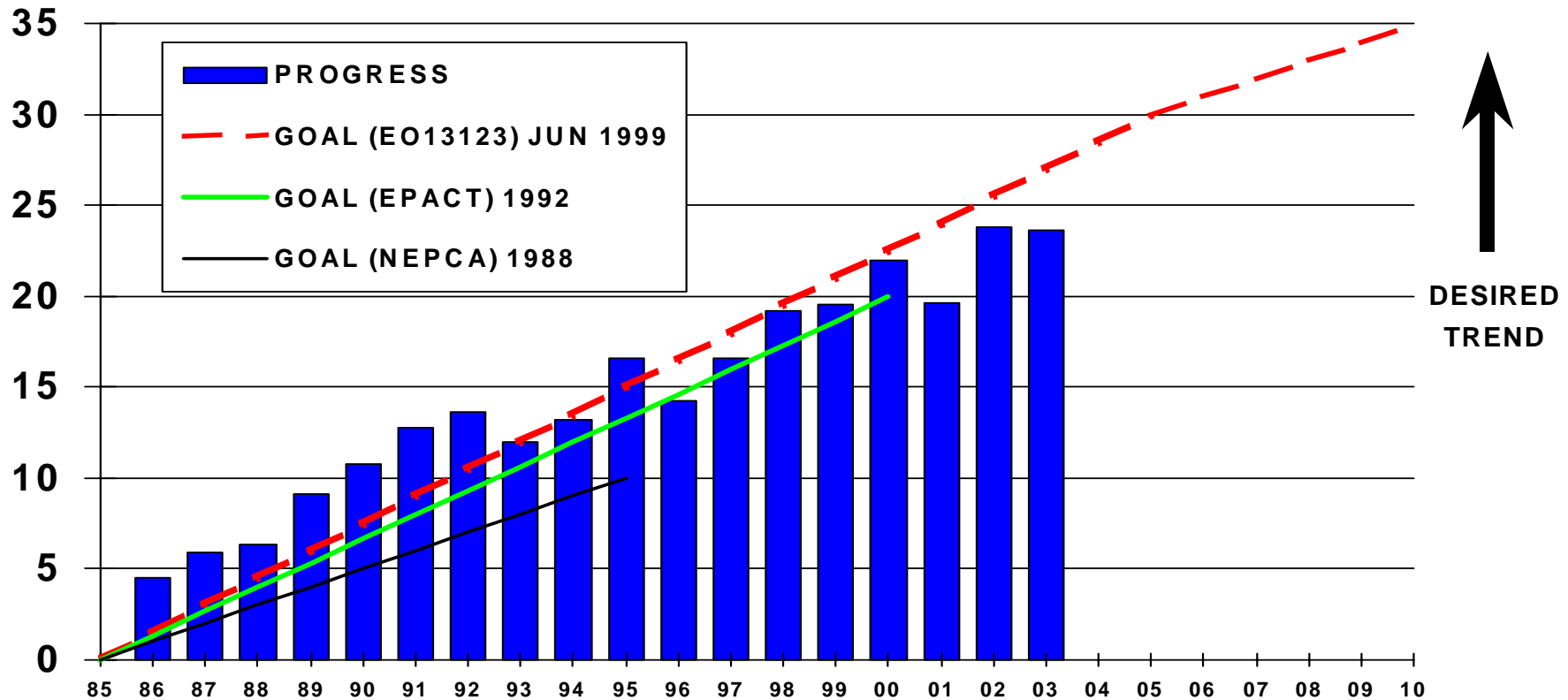
AF Situation for Energy Goals



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FY 03 PROGRESS = 23.6%

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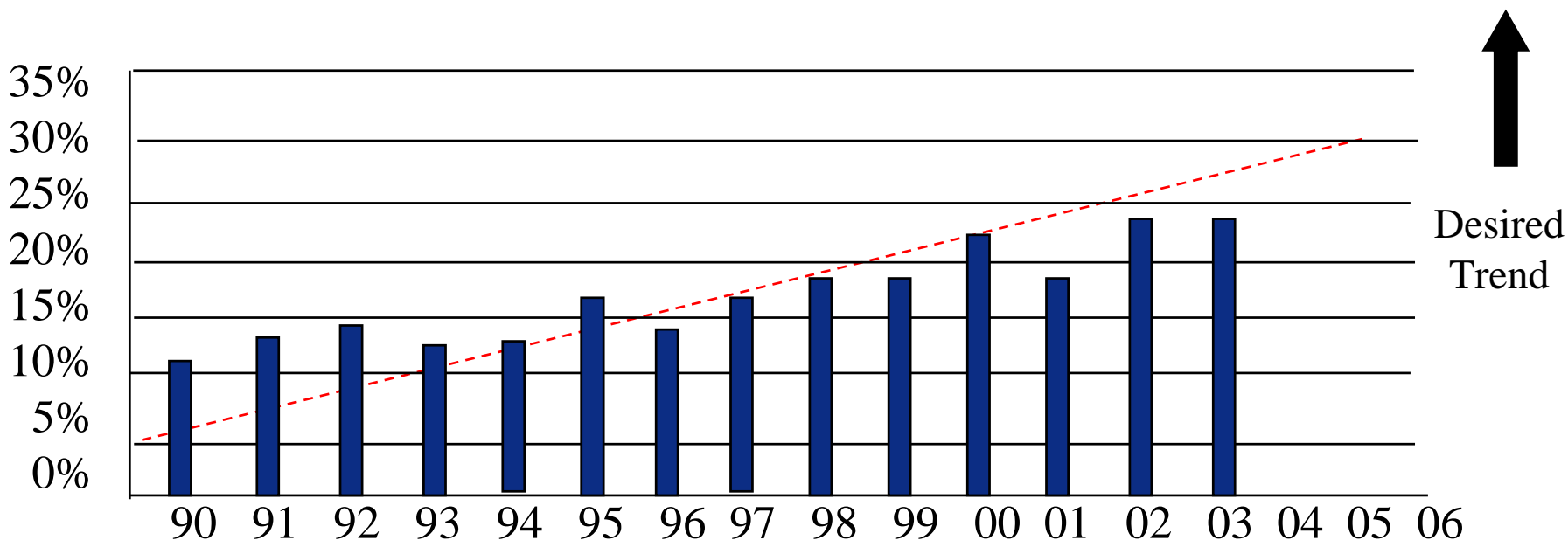


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Energy Savings Goals (Annual Targets)

■ Progress
- - - Goal (EO13123) Jun 1999

FY03 PROGRESS = 23.6%





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FY 03 USAF Facility Energy Consumption

78.7 trillion BTU's

\$793.3 million





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AWARDED ESPC PROJECTS

FY 03

BASE	MAJCOM	ESCO	Award Date	Awarded TO Total Contractor Investment	Awarded TO Total AF Payments to Contractor Over Life of TO
Dyess	ACC	Siemens	24 Sep 03	\$3,602,557	\$6,137,680
Dyess(Mod)	ACC	Siemens	06 Jan 04	\$7,094,449	\$11,547,571
NAS JRB	Navy	Siemens	20 Jun 03	\$3,736,350	\$6,171,959
Travis (Mod)	AMC	Honeywell	11 July 03	\$3,209,966	\$7,043,651



U.S. AIR FORCE

AWARDED ESPC PROJECTS

FY 03

BASE	MAJCOM	ESCO	Award Date	Awarded TO Total Contractor Investment	Awarded TO Total AF Payments to Contractor Over Life of TO
Hill	AFMC	Sempra	30 Sep 03	\$2,769,750	\$5,665,597
Hill	AFMC	Exelon	30 Sep 03	\$4,610,585	\$16,562,688
Kirtland	AFMC	Honeywell	26 Mar 03	\$2,195,000	\$7,980,339
Nellis	ACC	JCI	26 Sep 03	\$4,201,696	\$9,943,491
Beale	ACC	Chevron Tex	30 Sep 03	\$3,659,095	\$6,539,665
Elmendorf	PACAF	AMERESCO	29 Sep 03	\$48,841,031	\$123,605,931
Ramstein	USAFE	Siemens	31 Jul 03	\$1,623,074	\$3,648,475

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AF Position on Impact of Sunset Provision



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Sunset Language

42 USC 8287 (c), Sunset Provision

- **"The authority to enter into NEW contracts under this section shall cease to be effective on October 1, 2003."**



AFCESA DETERMINATION

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- **FAR Part 2, Definition for a delivery order is:**
 - **An order for supplies placed against an ESTABLISHED contract or with Government sources."**
 - **FAR Part 2 makes clear that task/delivery orders are not contracts themselves, but orders placed "against an established contract."**
- **Task/delivery orders are not considered by the AF to be "new contracts" under the Sunset Provision at 42 USC 8287(c) and, therefore, does not limit task order issuance after 30 Sept 03**



AFCESA DETERMINATION

U.S. AIR FORCE

- **Plain reading of 42 USC 8287 shows that entering into a contract" is contemplated to mean implementing the full blown procedures to "select and monitor" energy service contractors**
- **The AF does not engage in this process each time a task/delivery order is issued. The legislative intent of Congress on this particular issue is silent so the plain reading and FAR references should be followed**
- **The AF will continue to issue task orders against existing AF Regional ESPC contracts**



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Status of FY 04 Awards

■ AWARDED

- Kunsan AFB value \$1.5 MILLION**
- Osan AFB value \$3.5 MILLION**

■ PENDING

- Mountain Home AFB value \$2 MILLION**

■ IN PROCESS Mid CY AWARD Anticipated

- Altus AFB value \$2.5 MILLION**
- Lackland AFB value \$0.9 MILLION**
- Laughlin AFB value \$2.2 MILLION**

Headquarters U.S. Air Force

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AF ESPC M&V PROTOTYPE UPDATE



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Development of M&V Prototypes

■ GOALS OF DEVELOPMENT PROCESS

- Holistic Approach**
- Cost Effective M&V**
- Designed to Acquire and Maintain Savings for Installations**
- Designed to Accelerate Implementation**
- AFCESA introducing standard M&V Plans to address 80% of the needs**



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AF M&V, PROTOTYPE

■ DEVELOPMENT CONSIDERATIONS

- Measurements Start to Finish**
- Step-by-Step Development of the Process**
- Realistic Expectations**
- Realistic Measurements**
- Affordable Cost**
- Writer Friendly**
- Reader Friendly**
- Alternate Methods of Proof**
- Future Generations**
- Living Document**
- Requirements of 42 USC 8287**



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Development of M&V Prototypes

- **AFCESA / TAMU DEVELOPED MASTER M&V FORMAT**
 - Received USAF ESCO input
- **STATUS**
 - Six M&V prototypes posted to the HW AFCESA public website since 8 April 04
 - Two M&V prototypes reviewed but not finalized or posted to website
 - Three M&V prototypes received but not reviewed
 - Remaining M&V prototypes in progress
- **AFCESA WEBSITE ACCESS**

http://www.afcesa.af.mil/ces/cesm/energy/cesm_prototypes.asp



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Development of M&V Prototypes

- **ECP M&V PROTOTYPES Posted to Website**

http://www.afcesa.af.mil/ces/cesm/energy/cesm_prototypes.asp

- **EMCS**
- **Boilers**
- **Chillers**
- **Lighting**
- **Variable Speed Drives**
- **Constant Speed High Efficiency Motors**



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Development of M&V Prototypes

- **ECP PROTOTYPES WAITING FINALIZATION**
 - **Decentralization of Heating Plant**
 - **Central Chiller Plant**



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Development of M&V Prototypes

- **ECP PROTOTYPES IN REVIEW**
 - **Propane Air**
 - **Cooling Tower Replacement**
 - **Direct Expansion/Heat Pump Replacement**



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Development of M&V Prototypes

- **FUTURE ECP PROTOTYPES**
 - **Thermal Storage systems**
 - **Building Envelope**
 - **Infrared Heating**
 - **Steam Traps**
 - **Plate Heat Exchangers**
 - **FM Control Systems**
 - **HVAC Controls/Retrofit**



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Development of M&V Prototypes

- **TARGET DATE FOR COMPLETION**

- **30 SEPT 04**

- **WEBSITE (again)**

http://www.afcesa.af.mil/ces/cesm/energy/cesm_prototypes.asp

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M&V PROTOTYPE EXAMPLE



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AF M&V, LIGHTING

- 1. Measurement and Verification Summary**
- 2. Pre ECP Baseline Development**
 - 2.1. Pre ECP Energy Baseline**
 - 2.2. This Paragraph not used**
 - 2.3. Documentation of Baseline Utility Rates**
 - 2.4. Pre ECP O&M Cost Estimates (when applicable)**



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AF M&V, LIGHTING

3. ECP Requirements / Proposal

3.1. ECP Description

3.2. Predicted Post ECP Yearly Costs – Utility Usage

3.3. Predicted Post ECP O&M Costs

4. Yearly Savings – Utility and O&M

4.1. Annual Utility Savings

4.2. Predicted Utility Cost Savings

4.3. Predicted Yearly O&M Cost Savings

4.4. Predicted Total ECP Cost Savings (Utility and O&M)

4.5. Guaranteed Savings



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5. Acceptance

5.1. Acceptance Criteria – System Performance Requirements

5.2. Performance Criteria – Detailed Descriptions

5.3. Performance Acceptance Tests - Detailed Descriptions

5.3.1. Efficiency Tests

5.3.2. Capacity Tests

5.4. Measurement Equipment Used

5.5. Acceptance Checklist

5.5.1. Acceptance Documents



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6. Periodic / Interval Verification Activities

6.1. ECP Executive Overview

6.2. Contact Information

6.3 Year 1 Requirements

6.3.1. System Performance Criteria

6.3.2. System Performance Tests

6.3.3. Energy Performance Criteria

6.3.4. Energy Performance Tests

6.3.5. O&M Validation



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6.4 Year 1+N Requirements

6.4.1. System Performance Criteria

6.4.2. System Performance Tests

6.4.3. Energy Performance Criteria

6.4.4. Energy Performance Tests

6.4.5. O&M Validation



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- **Appendix A: Post-ECP Year 1 Detailed Savings Calculations and Reconciliation**
- **Appendix B: Post-ECP Year 1+N Detailed Savings Calculations and Reconciliation**



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■ Appendix C: Forms

C.1. Sampling Plan

C.2. Data Worksheet

C.3. Operating Schedule Worksheet

C.4. Measurement Specifications and Costs Worksheet

C.5. Acceptance Checklist Worksheet

C.6. Acceptance Checklist Worksheet

C.7. Year 1 Detailed Savings Worksheet

C.8. Year “1+N” Detailed Savings Worksheet



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- **Sampling Plan (C.1.) Excerpt**
 - **Percent (%) sampled determined by USAF with consideration to the confidence of the measurement . This sample should provide a confidence of 80% with a precision of +/- 20% or better. Figure C.1. Provides the required sample size with respect to population.**
 - **If the first sample fails then another sample should be taken with a sample sized to provide a confidence of 90% and a precision of 20%.**
 - **If the second sample fails 100% of the items will be tested.**



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■ Sampling Plan (C.1.) Table C.1.

Precision	20%	20%	10%
Confidence	80%	90%	90%
Population Size, N	Sample Size, n		
4	3	4	4
12	6	8	11
20	8	10	16
30	9	11	21
40	9	12	26
50	10	13	29
60	10	14	32
70	10	15	35
80	10	15	37
90	10	15	39
100	10	15	41
200	11	16	51
300	11	17	56
400	11	17	59
500	11	17	60
Infinite	11	17	68

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That's all Folks

Questions??????



U.S. AIR FORCE

USAF M&V TEMPLATE

“Lighting”

Energy Conservation Method

Guidance for Phase II Report

M&V Exhibit

Measurement and Verification Plan

“Lighting”

HQ Air Force Civil Engineering Support Agency

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TRIGEN

Introduction

This Guidance document describes the minimum requirements for Measurement and Verification (M&V) for use in USAF projects. This is one of a set of Guidance documents to assist contractors in performing M&V on specific Energy Conservation Project (ECPs). In the Air Force ESPC program ECPs are the individual building or technology specific projects encased inside the overall Energy Conservation Measure (ECM) for an entire base or installation. An individual Installation ECM will most likely be composed of many ECPs. ECMs are assigned as task orders to a regional contract.

M&V is the mechanism used by the ESCO and the Air Force to assure the Air Force actually receives the savings proposed in the contract documents. Cost effective M&V reduces risk to the contractor on savings disagreements and interrupted payments and will assure that the USAF realizes the guaranteed savings. The intent of this guidance is to help simplify the M&V approval process, achieve a commonality between all submittals and thus reduce overall M&V costs.

The overall approach is to identify the short and long term risks to maintaining the proper function and the savings of the retrofits and then to determine a cost effective approach to minimizing these risks. The goal is to keep the total M&V cost below 5% of the total savings, which is about midrange of that stated in the International Performance Measurement and Verification Protocol (IPMVP). M&V requirements cannot be based upon percentage of savings as the only guideline for acceptability. One must also consider the potential for loss of savings, loss of energy, maintenance costs and equipment life when developing M&V plans.

A total M&V Plan needs to include a separate M&V Plan for each ECP. Each ECP's M&V Plan must include provisions to validate performance of all major system components at acceptance, and then validate performance, savings, and O&M for all components for the plan to contribute to the validation of savings for the whole ECP over the life of the Task Order.

Note: The AF Designator ECP XX is an internal tracking number and should be dropped when this document is used as the basis for M&V.

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Guidance For M&V Plan Lighting ECP

1. Measurement and Verification (M&V) Plan Summary

- Executive overview with Lighting ECP description.
 - Include all planned Lighting retrofits and a brief description of how savings are achieved.
- Executive overview of the savings and the intent of the M&V.
 - Summary including the Lighting ECP cost, guaranteed savings, post ECP yearly cost of utility, O&M costs and simple payback.
 - Overall expectation for the M&V in relation to the risks / benefits / cost.
 - Identification of key risks by short and long term impact and risk mitigation for situations that could affect performance and savings.
 - Accuracy of assumed post-retrofit operating schedule.
 - Proper installation of the Ballast and Lamps.
 - Ensuring light levels are to code.
 - Proper Maintenance. (Including cleaning of lighting systems)
 - Change in operating schedules.
 - Correct replacement of Ballast and Lamps.
 - Other long-term system or energy performance risks.
 - Identification of Risk Reduction/Mitigation Actions (describe how M&V will mitigate or reduce risk).
 - Baseline development.
 - Briefly describe measurements completed during the Phase II effort.
 - Post-ECP requirements.
 - Briefly describe measurements planned.
 - Briefly describe savings verification and reconciliation requirements.
- Brief description of the acceptance and functional testing which will be required.
 - Briefly describe how the acceptance and functional testing will assure the ECP meets the requirements.
- The target cost of all M&V is 5% of the total ECM savings per year.
 - Costs of the Lighting M&V can rise or fall if justified by risk of savings loss.
 - T-12 to T-8 measures will normally be less than the 5% target
 - The post ECP utility costs and the cost of loss of performance must be a consideration in this decision.
- Brief discussion of operations and maintenance performance.

2. Pre-ECP Baseline Development

- Provide an overall description of the existing lighting system.
- Introduce as an overview how the Lighting Energy Consumption and Demand Baseline will be developed.
- Reference and complete the worksheet “Operating Schedules” (tab is named “OperatingScheds”) in Attachment 1, filename “ECP02_LGT.xls”, which is used to specify separate schedules and operating load profiles.

2.1. Pre-ECP Energy Baseline

- Write up the description of the Pre-ECP energy baseline and provide an overview of how the baseline will be acquired and quantified.
- Reference the spreadsheet detailing the list of the existing lighting systems (baseline), which will be retrofitted and include key parameters of lighting operations.
 - A template of this table is included in this report in paper and in Microsoft Excel (an electronic workbook) format as Attachment 1, filename “ECP02_LGT.xls”, in the data section(s) of the worksheets “Lighting Measurement Criteria, Data Measurements, and Cost Results” (tab name “LGT Data”) worksheet(s).
 - Include other relevant information as appropriate, which could cover using or upgrading the existing EMCS for Lighting data collection
- Use measurements to quantify existing lighting.
 - Complete the “Pre-ECP Measured / Database” columns of the “Lighting Measurement Criteria, Data Measurements, and Cost Results” worksheet, which is included in Attachment 1.
 - Directly measure power if fixture type is not previously measured for this base and added in database.
 - Use the lighting database if fixture type has previously been measured for this base or installation.
 - Sample lighting if sufficient quantity of similar lighting and applications dictates.
 - Operating schedules determined by measurements or by interviews and observations.
 - Validate schedules with sampling.
 - Run-time monitors, EMCS, EMCS trends, logged measurements, and existing control capabilities shall be used to verify schedules.
 - Use sampled op-hours if sufficient quantity of similar lighting and applications dictates.
 - Specify sampling method and procedures used to verify schedules.
 -
 - Specify sampling method and procedures used to verify lighting application operation or utility power consumption.
 - Minimum requirements determined by USAF. Additional measurements approved by USAF with consideration to the confidence of the measurement. The USAF is looking for a confidence of 80% with a precision of $\pm 20\%$ or better. Refer to Appendix C.1 for further details.
- Include a brief description of how baseline data was collected.

- Under what conditions was the data taken.
- Describe how any adjustment to the data was done (if done).
- Describe how missing data was handled if data was missing.
- Specify what metering equipment was used in the worksheet “Measurement Specifications and Costs” (tab is named “MeasSpecs”) in Attachment 1.
- Identify when meters were calibrated and to what standard.
- Describe any unusual conditions or energy usage in the baseline period.
- Describe any adjustments / changes to the energy use baseline. Specify any baseline adjustments for any other factors.
- Use measured data to determine operation and load profiles.
- Use operation and load profiles to quantify energy and demand operating profile. If demand savings are included, the lighting demand must be verified to be coincidence at specified levels when peak demand was historically set.
- A more conservative approach would be to not include weather interactions in either baseline or guaranteed savings values. “The ESCO” will either measure the impact of the lighting on the HVAC or use the provided USAF HVAC/Lighting Impact Table, which estimates the impact based on Heating Degree Days (HDDs) and Cooling Degree Days (CDDs). See Figure 2.1-1.
- Complete the column label “Cooling Savings/Heating Penalty” in the “Lighting Measurement Criteria, Data Measurements, and Cost Results” (tab is named “LGT Data”) worksheet using the information found in the “Data Column Definitions (tab is named “DataColumnDef”) worksheet of Attachment 1.

Heating Degree Days HDD's	Heating Penalty	Cooling Degree Days CDD's	Cooling Savings	
<1000	1%	<1000	2%	Multiply the Net HVAC Impact times the total lighting savings to obtain the additional savings. For example, if HDD = 1400 and CDD = 2200, the net savings multiplier is +5.5%.
1000 - 2000	2.50%	1000 - 2000	5%	
2001 - 3000	4%	2001 - 3000	8%	
3001 - 4000	5.50%	3001 - 4000	11%	
4001 - 5000	7%	4001 - 5000	14%	

Figure 2.1-1. Approved Estimating Table for HVAC Impact from Lighting ECPs

- Baseline adjustment for other factors.

2.2. This Paragraph Not Used.

2.3. Documentation of Baseline Utility Rates

- Attach copies and reference the location in this Report of all utility rate structures used. These must be fully documented
- Description of all rates and how obtained, with copies of the utility bills when available. These can be obtained from the USAF or the utility. If not available, reasons must be listed.
- Escalation is not normally used. If approved by USAF Major Command, consult AFCEA ULT for utility rate escalation. Utility rate escalation cannot exceed the

rates in the Annual supplement to the most current NIST Handbook 135, “Energy Price Indices and Discount Factors for Life-Cycle Cost Analysis”.

- Any escalation or variation from current utility rates must be clearly documented.

2.4. Pre-ECP O&M Cost Estimates (When Applicable)

- The yearly average costs derived from the O&M cost data shall be clearly documented.
- Describe all costs and how obtained. O&M costs must be obtained from the base CE.
- Complete the “Pre-ECP Financial” columns of the “Lighting Measurement Criteria, Data Measurements, and Cost Results” (tab name is “LGT Data”) worksheet(s) in Attachment 1.

3. ECP Requirements / Proposal

- May have a paragraph to introduce Section 3 or can leave blank.

3.1. ECP Description

- Overall description of the new system.
- Discussion of how the savings are generated.
- Description of energy and O&M savings.
- Describe the major risks on achieving the savings.
 - Describe the operational and performance requirements that the system must achieve.
 - Lighting key risks to achieving savings are usually establishing the lighting fixture consumption (lamps plus ballast) and the occupancy schedule.
 - Describe how the acceptance tests will validate these requirements.
- Describe the risk / responsibility matrix and risk reduction / mitigation measures.
 - Government risks include:
 - Operations schedules.
 - Changing rate schedules.
 - Other.
 - ESCO risks include:
 - Lighting sizing to achieve performance.
 - Lighting selection to achieve savings.
 - Operations and maintenance to maintain savings and preserve lighting life and light levels.
 - Early lighting failure.
 - Other.
 - Describe in detail how the ESCO will reduce / mitigate risk.
 - Describe general measures to reduce / mitigate risk.
 - Describe how M&V will reduce / mitigate risk.

3.2. Predicted Post ECP Yearly Costs – Utility Usage

- Include all calculations / worksheets with a detailed description of any ESCO developed calculations in the appendix.
 - All variables must be defined with equations described using the variables.

- Complete the “Predicted Performance” columns provided in the “Lighting Measurement Criteria, Data Measurements, and Cost Results” (tab name is “LGT Data”) worksheet(s) in Attachment 1 with values for the annual demand and consumption predicted for each lighting system with comments as appropriate.

3.3. Predicted Post ECP O&M Costs

- Brief discussion of which organization will perform O&M between the USAF and the ESCO.
- Briefly, discuss maintenance needed in the new system.
 - For light bulbs and ballasts, maintenance responsibility and costs must be clearly stated.
- Reference exhibit(s) showing O&M costs and cost predictions.
- Detailed discussion of how O&M costs were calculated, include all calculations in the Appendix.
- Include a statement that the ESCO is responsible for O&M even if USAF performs maintenance. If the USAF assumes original maintenance at the start, include a statement on the circumstances that the ESCO would take over O&M from the USAF.

4. Yearly Savings - Utility and O&M

4.1 Annual Utility Savings

- Detailed discussion of demand and energy savings calculations, include detailed calculations in Appendix.
- Supporting documentation must be submitted with any calculations or worksheets to describe the results provided.

4.2 Predicted Utility Cost Savings

- Complete the “Post-ECP Predicted Financial” columns of the “Lighting Measurement Criteria, Data Measurements, and Cost Results” (tab name is “LGT Data”) worksheet(s) in Attachment 1.
- Supporting documentation must be submitted with any calculations or worksheets to describe the results provided.

4.3 Predicted Yearly O&M Cost Saving

- Sum up of the Pre and Post O&M cost savings. Complete the appropriate columns of the above worksheet.
- Supporting documentation must be submitted with any calculations or worksheet(s) to describe the results provided.

4.4 Predicted Total ECP Cost Savings (Utility and O&M)

- Total savings (sum up of the Annual Utility Cost Savings plus O&M Cost Savings).

4.5. Guaranteed Savings

- Detail the guaranteed savings as related to the calculated savings. Complete the Guarantee column in the “Post-ECP Predicted Financial” columns of the “Lighting Measurement Criteria, Data Measurements, and Cost Results” (tab name is “LGT Data”) worksheet(s) in Attachment 1. State any discounting that is being done from the calculated savings to make the guarantee more conservative.
- Escalation is not normally used or allowed for energy costs. If approved by USAF, then any escalation must be clearly documented. Cannot exceed the rates in the Annual supplement to the most current NIST Handbook 135, “Energy Price Indices and Discount Factors for Life-Cycle Cost Analysis”.
- Fill out the spreadsheet column with guaranteed values per item in the data worksheets of Attachment 1.

5. Acceptance

- Include an overview of what factors the acceptance, performance, efficiency and capacity tests seek to verify.
- Describe how or what methods will be used to verify those factors and what the minimum levels of acceptable results are.
- Review of ECP risks.
 - State how acceptance tests address the Lighting short and long-term risks.
 - Include operational performance and energy performance.

5.1. Acceptance Criteria – System Performance Requirements

- Include an overview and list of criteria detailing what is required for acceptance.
 - Overview of the acceptance shall clearly identify tests and data required for acceptance of ECP and initiation of payment stream at the end of construction phase (Phase 3).
 - Performance criteria shall also be clearly identified based on installed lighting in order to meet the predicted and guaranteed energy efficiency and system performance during the initial and subsequent annual periods.
- Complete worksheets in Attachment 1. ESCO can extend worksheet if required for the Lighting ECP.
 - Some actual measured data may have to be filled in during Phase III.
 - Complete construction acceptance information in the “Acceptance Checklist” (tab name is “AcceptChecklist”) worksheet(s) in Attachment 1.
 - Complete performance information in the “Post-ECP Acceptance Measured” columns of the “Lighting Measurement Criteria, Data Measurements, and Cost Results” (tab name is “LGT Data”) worksheet(s).
 - Performance must be at specified acceptable values for acceptance to occur.

5.2. Performance Criteria – Detailed Descriptions

- Performance criteria for the annual measurements and report shall be those agreed upon for the Lighting ECP.
- Include reporting format (sample table) with each reported variable specified.

- The performance criteria are specified in the “Lighting Measurement Criteria, Data Measurements, and Cost Results” (tab name is “LGT Data”) worksheet(s) in Attachment 1 under the column “Light Level Meas (FC)”.
 - Performance can be measured by verifying that the equipment provides adequate light to maintain the operational requirements per IES standards.
- State that the data will be provided to USAF.

5.3. Performance Acceptance Tests – Detailed Descriptions

- Performance tests specified in the Post-ECP Measured / Inspected columns the “Lighting Measurement Criteria, Data Measurements, and Cost Results” (tab name is “LGT Data”) worksheet(s), in Attachment 1, shall be measured as part of the initial and annual performance tests.
- Measure and record the required parameters shown in “Post-ECP Acceptance Measured” columns of the “Lighting Measurement Criteria, Data Measurements, and Cost Results” (tab name is “LGT Data”) worksheet(s) in Attachment 1.
- Include reporting format (with any sample graphs or tables) with each reported variable specified.
 - Include descriptive graphs.
 - State that specific performance variables will be approved by the USAF.
- Specify how the performance tests will be done.
- Show or reference equations that are used (if any).
- Include specifications for pass / fail and with detailed requirement on any retesting.
- Specify the situations that may cause USAF to require re-testing.
- Reference the detailed testing and calculation procedures in the Appendix.
- If appropriate for the application:
 - Verify controls are operational.
 - Verify proper light levels in accordance with IES standards.
 - Record power / current if fixture type is not in fixture database.
 - If connected to EMCS, verify correct operation including all Trend Logs and automated reports from the EMCS.

5.3.1. Efficiency Tests

- Efficiency Tests are not required for this ECP.

5.3.2. Capacity Tests

- Capacity Tests are required for this ECP.
 - Fixture watts measured in support of fixture database.
 - Light levels measured to verify light levels are in accordance with IES standards for the current usage of the space being lighted.

5.4. Measurement Equipment Used

- Maintain records of the equipment used in the performance testing including information such as:
 - Type of Equipment (manufacture, model number).
 - Accuracy.
 - Calibration frequency to be specified (typically yearly).

- A template of this including key parameters is available in the “Measurement Specifications and Costs” worksheet (tab name is “MeasSpecs”) worksheet in Attachment 1.

5.5. Acceptance Checklist

- A template worksheet “Acceptance Checklist” (tab name is “AcceptChecklist”) with a minimum set of requirements is included in Attachment 1. The checklist shall include all items to be checked during the acceptance testing.
- Include specifics on acceptance testing with the checklist, to be used with any modifications – subject to USAF approval. Acceptance checklist shall include the agreed upon measurements, calculations, and format.
- Include and identify any necessary clarifying diagrams, drawings or other documents.

5.5.1. Acceptance Documents

- A sample of the worksheet “Acceptance Report” (tab name is “AcceptRept”) is provided in Attachment 1. This document contains the minimum requirements for the acceptance sign-off.
- State what level of employee will provide these documents.

6. Periodic / Interval Verification Activities

- The cover sheet must include contract information, ECP information, and date of issue.
 - The normal interval will be one year.
 - Section 6 will be reissued with updated information each year.
- This Section 6 document will be included with the initial submittal.

6.1. ECP Executive Overview

- Summarize the savings guarantee and the savings achieved.
- A summary of any lighting changes.
- Include the original Executive Overview, Section 1.0 of the M&V Plan.

6.2. Contact Information

- Base Contacts (includes CO, EM, and CE complete addresses).
- ESCO Contacts (includes complete addresses and contact information for the M&V personnel, site manager and the project manager).

6.3. Year 1 Requirements

- Specify all documents that will be provided.
- Provide the reconciliation equations for the first year of operation.
- List dates and times of all tests and procedures performed. Include durations and frequencies for each item performed.
- List and explain any stipulated values for the ECP.
- List and explain any savings adjustments necessary.
- List commodity rate(s) and explain difference if not that stated in the original report.
- Define and explain any approved changes in scope / results recorded in the Acceptance Report.
- List equipment used in testing and provide current calibration information.
- Define the performance measurements required to meet established criteria for the energy guarantee.
 - Verify that specified system feedback controls (if present) operate as specified.
- System performance tests are covered in 6.3.2.
- Energy performance tests are covered in 6.3.4.
- Determine the operation and load profile such that the post-ECP energy consumption and demand can be quantified.
- Determine the cost and the savings for the first year.
- Complete the “Year 1 - Post-ECP Yearly Reconciliation” columns of the “Lighting Measurement Criteria, Data Measurements, and Cost Results” (tab name is “LGT Data”) worksheet(s) provided as Attachment 1.

6.3.1. System Performance Criteria

- The system performance criteria must be specified. These are included in the “Lighting Measurement Criteria, Data Measurements, and Cost Results” (tab name is “LGT Data”) worksheet(s) provided as Attachment 1.

6.3.2. System Performance Tests

- Performance tests will be done on an as needed basis to minimize cost. The USAF may request testing and if the lighting is deficient, the contractor will bring up to specifications. If the lighting is not deficient, the USAF will bear the cost of the testing.
- Yearly testing will involve verification that the bulbs and ballasts are available to the facilities and are being used when burn-outs occur. Lighting levels will also be measured on a statistical basis according to Appendix C.1.

6.3.3. Energy Performance Criteria

- The energy performance test criteria allow the consumption of the lighting be stipulated based on the fixture type once a sample set of measurements have been made for that fixture type.
- The lighting consumption will be:
 - The stipulated value with the agreed to discount on accepted savings, or
 - The agreed upon calculated value based on sampled measurements.
 - Calculate the savings due to changed lighting operating conditions, which must be reviewed and approved by the USAF.
 - Determine savings based on hours of operation and the consumption value. Allow a percent (to be determined by circumstances of the ECP) of the calculated savings to be used in the guarantee.

6.3.4. Energy Performance Tests

- Measure the power in the number of fixtures of each fixture group type as specified in Appendix “C.1. Sampling Plan”. This will be done once and then set for the life of the Task Order. Adjustment to the savings payment amount must be made if the total power consumption is more than that indicated in the Phase II report.
- A sample of the Annual Report Year N is provided in Attachment 1 worksheet labeled as worksheet tab “AnnualRept”. This represents the minimum requirements for the acceptance document for the performance tests that will be done.
- Provide, or acknowledge availability of, the required measurements in the “Year 1 - Post-ECP Yearly Reconciliation Measured” columns of the “Lighting Measurement Criteria, Data Measurements, and Cost Results” (tab name is “LGT Data”) worksheets provided as Attachment 1.
 -
 - If an EMCS is available, provide, or acknowledge availability the 15-minute or hourly data run time and energy over the year for other lighting.
- Specify the reconciliation equations for the first year of operation through the end of the Task Order.
- Verify lighting is operational, if not repair or replace or notify the appropriate entity, as required.
- Verify lighting is being used, if not, put back into service or notify the appropriate entity, as appropriate.
- Specify the testing required at the end of each year.

- Measure or verify lighting levels on a sampled basis.
- Sample set selected, approved or accepted by USAF.
- Measure operating schedules continuously over the year; record at specified intervals for all lighting where an EMCS is available per the previously defined sampling plan.
- Derive, measure or verify operating hours for lighting over a certain size per previously defined sampling plan.
- Inspection of a sample set of buildings to verify that the correct ballasts and lamps are available.
- Specify all documents that will be provided each year.

6.3.5. O&M Validation

- Provide explanation and description of how proper O&M was achieved or validated.
- Detail any deficiencies to be addressed by the ESCO or the Air Force.
- Provide dialog on effects of O&M deficiencies on generation of savings.

6.4. Year “1+N” Requirements

- Specify all documents that will be provided each year.
- Define Year “1+N” Annual Verification Requirements.
 - Measure or verify lighting levels on a sampled basis.
 - Sample set selected, approved or accepted by USAF.
 - Inspection of a sample set of buildings to verify that the correct ballasts and lamps are available.
- Identify details of any other differences between year 1 and subsequent year requirements.

6.4.1. System Performance Criteria

- Define Year “1+N” Requirements.
 - Lighting levels must be verified or measured on a sampled basis.
 - Correct ballasts and lamps must be used as replacement parts.
-

6.4.2. System Performance Tests

- Define Year “1+N” Requirements.
 - Measure lighting levels to IES standards for spaces sampled
 - Verify correct ballasts and lamps are stocked being used.

6.4.3. Energy Performance Criteria

- Energy performance criteria are met if the system tests are acceptable.
- Additional energy performance testing can be requested by the USAF at any time.
 - If the energy consumption of the USAF selected fixtures exceeds the guaranteed level, the contractor will repair to meet the guaranteed level.
 - If the energy consumption is at or below the guaranteed level, the USAF will be responsible for the cost of the testing required.
-

6.4.4. Energy Performance Tests

- Define Year “1+N” Requirements if different from the normal power consumption tests.

6.4.5. O&M Validation

- Provide explanation and description of how proper O&M was achieved or validated.

6.5. Savings Calculations / Reconciliation

- Provide an overview of savings calculations and reconciliation for year 1 through the end of the task order.
- Provide the reconciliation equations for the first year of operation through the end of the Task Order.

6.5.1. Year 1 Savings Calculations / Reconciliation

- Specify the Energy Performance test and reference the detailed calculations in the Appendix.
- Specify the equations that the reconciliation will be based upon. If different from those previously identified or proposed, provide justification for the difference.
- Specify the cost calculations for energy and demand. If different from previously identified calculations, provide justification for the difference.
- Specify the options to achieve the guaranteed savings if the savings are not attained.
- Specify conditions under which the ESCO can rework the lighting / lighting controls and then retest to verify the savings have been acquired.

6.5.2. Year “1+N” Savings Calculations / Reconciliation

- The Savings Calculations / Reconciliation will be the agreed to amount if the results of the system performance and energy performance tests are acceptable. The USAF must approve any redefinitions.

Appendix A. Post-ECP Year 1 Detailed Savings Calculations and Reconciliation

- Specify all calculations and associated variables that are used in the savings and reconciliation calculations.
- Specify conditions under which the ESCO can sample loads for partial measurements.
- Specify which calculations are required for the acceptance testing and which are required for the annual testing.
- If the baseline was not measured during the Pre-ECP period, specify how the sampling will be done during the first year of operation to attain a baseline. Also, specify the discount that will be applied to the calculated savings, if appropriate.

Appendix B. Post-ECP Year “1+N” Detailed Savings Calculations and Reconciliation

- Savings and reconciliation will be determined using acceptance testing. This amount will be used as long as the results of the yearly sampled inspection and lighting level measurements are acceptable.
- Obtain USAF approval for any changes.

Appendix C. Forms

C.1. Sampling Plan

- Identify the sampling plan proposed to, accepted by or approved by the USAF.
 - The purpose of sampling is to monitor a representative sample of points rather than the entire population. The end result is to obtain reliable estimates within a specified precision and statistical confidence. Monitoring the specified number of points (that are calculated from sampling equations) does not necessarily mean the ESCO has complied with the requirements of the M&V plan. If usage groups are improperly designated, incorrect sample design assumptions are used, or nonrandom points are selected it may lead to sample-based estimates that are biased and/or unreliable within specified levels. It is critical that extreme care be taken during the initial developmental stages to design a sample that truly reflects the project site.
 - Percent (%) sampled determined by USAF with consideration to the confidence of the measurement. The sample should provide a confidence of 80% with a precision of $\pm 20\%$ or better. Figure C.1 provides the required sample size with respect to population.
 - If the first sample fails then another sample should be taken with a sample sized to provide a confidence of 90%.
 - If the second sample fails 100% of the items will be tested.
- Provided as a separate document if required.
- Sampling plan required for baseline, acceptance and annual plan(s).

Precision	20%	20%	10%
Confidence	80%	90%	90%
Population Size, N	Sample Size, n		
4	3	4	4
12	6	8	11
20	8	10	16
30	9	11	21
40	9	12	26
50	10	13	29
60	10	14	32
70	10	15	35
80	10	15	37
90	10	15	39
100	10	15	41
200	11	16	51
300	11	17	56
400	11	17	59
500	11	17	60
Infinite	11	17	68

Fig. C-1

Sample Sizes Based on a Population

- Include or reference a table detailing key parameters of lighting operations.
 - A template of this table is included in this report in paper and in Microsoft Excel (an electronic workbook) format as Attachment 1, filename "ECP02_LGT.xls", in the "Lighting Measurement Criteria, Data Measurements, and Cost Results" (tab name is "LGT Data") worksheet.

C.2. Data Worksheet

- The worksheet named "Lighting Measurement Criteria, Data Measurements, and Cost Results" (tab name is "LGT Data") is included in Attachment 1. This worksheet contains the measurement data, accuracy, and calculations, as well as specific information for the ECP.

C.3. Operating Schedule Worksheet

- The worksheet named “Operating Schedules” (tab is named “OperatingScheds”) is included in Attachment 1. This worksheet is used to specify separate schedules and operating load profiles.

C.4. Measurement Specifications and Costs Worksheet

- The worksheet named “Measurement Specifications and Costs” (tab is named “MeasSpecs”) is included in Attachment 1. This worksheet is used to specify the measurement lighting, calibration and measurement costs.

C.5. Acceptance Checklist Worksheet

- The worksheet named “Acceptance Checklist” (tab is named “AcceptChecklist”) is included in Attachment 1. This worksheet is used to specify the installation acceptance criteria.

C.6. Acceptance Report Worksheet

- The worksheet named “Acceptance Report” (tab is named “AcceptRept”) is included in Attachment 1. This worksheet is used to certify that the listed items in the Acceptance Checklist were properly completed.

C.7. Year 1 Detailed Savings Worksheet

- The worksheet named “Lighting Measurement Criteria, Data Measurements, and Cost Results” (tab name is “LGT Data”) worksheet is included in Attachment 1. This worksheet contains the measurement data, accuracy, calculations and cost tracking for the ECP.

C.8. Year “1+N” Detailed Savings Worksheet

- The worksheet named “Lighting Measurement Criteria, Data Measurements, and Cost Results” (tab name is “LGT Data”) worksheet is included in Attachment 1. This worksheet contains the measurement data, accuracy, calculations and cost tracking for the ECP.

Lighting Data Measurement and Cost

Building Information*									Pre-ECP Measured/Database				Post-ECP Predicted Performance			
Bld ID	Rm Name / #	Loc	Bld Sched	Bldg / Room Desc	Yearly Op Hrs	Cooling Savings/ Heating Penalty	Lighting Diversity Factor	Light Level Req (FC)	Qty Fixt's	Fixt Cap (W)	Fixt Type	Light Level Meas (FC)	Qty Fixt's	Fixt Cap (W)	Fixt Type	Light Level Meas (FC)
1201_HQ_101	HQ	101	3	Office	4380	1.055	0.95	35	18	188	F40-4 -	35	18	111	F32T8-4	35
1201_HQ_103	HQ	103	5	Office	5110	1.055	0.95	35	16	188	F40-4 -	35	16	112	F32T8-4	35
1201_HQ_104	HQ	104	5	Office	5110	1.055	0.95	35	17	188	F40-4 -	36	17	115	F32T8-4	36
1202_PX_101	BX	101	5	Office	5110	1.055	0.95	35	21	188	F40-4 -	38	21	115	F32T8-4	38
1202_PX_102	BX	102	5	Office	5110	1.055	0.95	35	18	188	F40-4 -	36	18	112	F32T8-4	36
1202_PX_103	BX	103	5	Office	5110	1.055	0.95	35	23	188	F40-4 -	36	23	114	F32T8-4	36
1202_PX_104	BX	104	4	Office	4745	1.055	0.95	35	19	188	F40-4 -	37	19	113	F32T8-4	37
1203_CO A_101	CO A	101	6	Office	5475	1.055	0.95	35	17	188	F40-4 -	38	17	113	F32T8-4	38
1203_CO A_102	CO A	102	3	Office	4380	1.055	0.95	35	21	188	F40-4 -	36	21	115	F32T8-4 EI	36
1203_CO A_103	CO A	103	4	Office	4745	1.055	0.95	35	18	188	F40-4 -	36	18	115	F32T8-4 EI	36
1203_CO A_104	CO A	104	7	Office	8760	1.055	0.95	35	18	188	F40-4 -	39	18	113	F32T8-4 EI	39
1204_CO B_101	CO B	101	4	Office	4745	1.055	0.95	35	18	188	F40-4 -	38	18	115	F32T8-4 EI	38
1204_CO B_102	CO B	102	3	Office	4380	1.055	0.95	35	18	188	F40-4 -	38	18	115	F32T8-4 EI	38
1204_CO B_103	CO B	103	6	Office	5475	1.055	0.95	35	18	188	F40-4 -	38	18	114	F32T8-4 EI	38
1204_CO B_104	CO B	104	5	Office	5110	1.055	0.95	35	18	188	F40-4 -	37	18	115	F32T8-4 EI	37
1205_CO C_101	CO C	101	4	Office	4745	1.055	0.95	35	5	188	F40-4 -	39	5	113	F32T8-4 EI	39
1205_CO C_102	CO C	102	3	Office	4380	1.055	0.95	35	18	188	F40-4 -	38	18	110	F32T8-4 EI	38
1205_CO C_103	CO C	103	5	Office	5110	1.055	0.95	35	27	188	F40-4 -	36	27	111	F32T8-4 EI	36
1205_CO C_104	CO C	104	5	Office	5110	1.055	0.95	35	16	188	F40-4 -	39	16	114	F32T8-4 EI	39
1206_CO D_101	CO D	101	5	Office	5110	1.055	0.95	35	17	188	F40-4 -	36	17	115	F32T8-4 EI	36
1206_CO D_102	CO D	102	5	Office	5110	1.055	0.95	35	21	188	F40-4 -	35	21	110	F32T8-4 EI	35
1206_CO D_103	CO D	103	6	Office	5475	1.055	0.95	35	18	188	F40-4 -	39	18	110	F32T8-4 EI	39
1206_CO D_104	CO D	104	5	Office	5110	1.055	0.95	35	23	188	F40-4 -	36	23	110	F32T8-4 EI	36
1207_CO E_101	CO E	101	5	Office	5110	1.055	0.95	35	19	188	F40-4 -	37	19	113	F32T8-4 EI	37
1207_CO E_102	CO E	102	5	Office	5110	1.055	0.95	35	17	188	F40-4 -	39	17	113	F32T8-4 EI	39
1207_CO E_103	CO E	103	6	Office	5475	1.055	0.95	35	21	188	F40-4 -	39	21	112	F32T8-4 EI	39
1207_CO E_104	CO E	104	5	Office	5110	1.055	0.95	35	18	188	F40-4 -	37	18	110	F32T8-4 EI	37
1208_CO F_101	CO F	101	5	Office	5110	1.055	0.95	35	18	188	F40-4 -	37	18	113	F32T8-4 EI	37
1208_CO F_102	CO F	102	5	Office	5110	1.055	0.95	35	18	188	F40-4 -	35	18	115	F32T8-4 EI	35
1208_CO F_103	CO F	103	5	Office	5110	1.055	0.95	35	18	188	F40-4 -	39	18	112	F32T8-4 EI	39
1208_CO F_104	CO F	104	5	Office	5110	1.055	0.95	35	18	188	F40-4 -	38	18	112	F32T8-4 EI	38
1209_CO G_101	CO G	101	4	Office	4745	1.055	0.95	35	31	188	F40-4 -	38	31	114	F32T8-4 EI	38

Post-ECP Acceptance Measured							Pre-ECP Financial			Post-ECP Predicted Financial					Post-ECP Financial At Acceptance				
Performance Criteria							Elect Use (kWh)	Dmd (kW)	Cost** (\$)	Elect Use (kWh)	Dmd (kW)	Cost** (\$)	Savings (\$)	Guarantee (\$)	Elect Use (kWh)	Dmd (kW)	Cost** (\$)	Savings (\$)	Guarantee (\$)
Qty Fixt's	Fixt Cap (W)	Fixt Type	Light Level Meas (FC)	Lighting Functional	Date	By													
18	111	F32T8-4	35	Yes	3/20/03	JAC	14855	3.4	1,201	8798	2.0	711	490	465	8798	2	711	490	465
16	112	F32T8-4	35	Yes	3/20/03	CKM	15405	3.0	1,178	9139	1.8	699	479	455	9139	2	699	479	455
17	115	F32T8-4	36	Yes	3/20/03	CKM	16368	3.2	1,251	10021	2.0	766	485	461	10021	2	766	485	461
21	115	F32T8-4	38	Yes	3/21/03	WKD	20220	4.0	1,546	12398	2.4	948	598	568	12398	2	948	598	568
18	112	F32T8-4	36	Yes	3/21/03	WKD	17331	3.4	1,325	10323	2.0	789	536	509	10323	2	789	536	509
23	114	F32T8-4	36	Yes	3/21/03	JAC	22145	4.3	1,693	13466	2.6	1029	663	630	13466	3	1029	663	630
19	113	F32T8-4	37	Yes	3/21/03	JAC	16987	0.0	849	10222	0.0	511	338	321	10222	0	511	338	321
17	113	F32T8-4	38	Yes	3/21/03	CKM	17537	3.2	1,310	10581	1.9	790	520	494	10581	2	790	520	494
21	115	F32T8-4	36	Yes	3/21/03	CKM	17331	4.0	1,401	10615	2.4	858	543	516	10615	2	858	543	516
18	115	F32T8-4	36	Yes	3/21/03	WKD	16093	0.0	805	9816	0.0	491	314	298	9816	0	491	314	298
18	113	F32T8-4	39	Yes	3/21/03	WKD	29711	3.4	1,944	17825	2.0	1166	778	739	17825	2	1166	778	739
18	115	F32T8-4	38	Yes	3/21/03	JAC	16093	0.0	805	9860	0.0	493	312	296	9860	0	493	312	296
18	115	F32T8-4	38	Yes	3/21/03	JAC	14855	3.4	1,201	9117	2.1	737	464	441	9117	2	737	464	441
18	114	F32T8-4	38	Yes	3/21/03	CKM	18569	3.4	1,387	11273	2.1	842	545	518	11273	2	842	545	518
18	115	F32T8-4	37	Yes	3/21/03	CKM	17331	3.4	1,325	10572	2.1	808	517	491	10572	2	808	517	491
5	113	F32T8-4	39	Yes	3/22/03	WKD	4470	0.0	224	2681	0.0	134	89	85	2681	0	134	89	85
18	110	F32T8-4	38	Yes	3/22/03	WKD	14855	3.4	1,201	8696	2.0	703	498	473	8696	2	703	498	473
27	111	F32T8-4	36	Yes	3/22/03	WKD	25997	5.1	1,987	15378	3.0	1175	812	771	15378	3	1175	812	771
16	114	F32T8-4	39	Yes	3/20/03	JAC	15405	3.0	1,178	9316	1.8	712	465	442	9316	2	712	465	442
17	115	F32T8-4	36	Yes	3/20/03	CKM	16368	3.2	1,251	10022	2.0	766	485	461	10022	2	766	485	461
21	110	F32T8-4	35	Yes	3/21/03	WKD	20220	4.0	1,546	11880	2.3	908	637	606	11880	2	908	637	606
18	110	F32T8-4	39	Yes	3/21/03	JAC	18569	3.4	1,387	10901	2.0	814	573	544	10901	2	814	573	544
23	110	F32T8-4	36	Yes	3/21/03	JAC	22145	4.3	1,693	12967	2.5	991	702	667	12967	3	991	702	667
19	113	F32T8-4	37	Yes	3/21/03	CKM	18294	3.6	1,398	10952	2.1	837	561	533	10952	2	837	561	533
17	113	F32T8-4	39	Yes	3/21/03	CKM	16368	3.2	1,251	9810	1.9	750	501	476	9810	2	750	501	476
21	112	F32T8-4	39	Yes	3/21/03	WKD	21664	4.0	1,618	12946	2.4	967	651	618	12946	2	967	651	618
18	110	F32T8-4	37	Yes	3/21/03	WKD	17331	3.4	1,325	10181	2.0	778	547	519	10181	2	778	547	519
18	113	F32T8-4	37	Yes	3/21/03	JAC	17331	3.4	1,325	10380	2.0	794	531	505	10380	2	794	531	505
18	115	F32T8-4	35	Yes	3/21/03	CKM	17331	3.4	1,325	10629	2.1	813	512	487	10629	2	813	512	487
18	112	F32T8-4	39	Yes	3/21/03	CKM	17331	3.4	1,325	10337	2.0	790	535	508	10337	2	790	535	508
18	112	F32T8-4	38	Yes	3/22/03	WKD	17331	3.4	1,325	10279	2.0	786	539	512	10279	2	786	539	512
31	114	F32T8-4	38	Yes	3/20/03	JAC	27716	0.0	1,386	16761	0.0	838	548	520	16761	0	838	548	520

Year 1 - Post-ECP Yearly Reconciliation													
Database / Measured	Measured					Financial				Verified			
	Light Level Meas (FC)	Correct Lamps in Stock	Ballast Avail in Stock	Elect Use (kWh)	Dmd (kW)	Cost** (\$)	Savings (\$)	Savings Amount Over Guarantee (\$)	Reconciliation (\$)	Ballast/Bulb Functional	Deficiencies Corrected	Date	By
D	35	Yes	Yes	8798	2.0	711	490	222	0	Yes	-	3/20/2004	JAC
D	35	Yes	Yes	9139	1.8	699	479	220	0	Yes	-	3/20/2004	CKM
D	36	Yes	Yes	10021	2.0	766	485	281	0	Yes	-	3/20/2004	CKM
M	38	Yes	Yes	12398	2.4	948	598	350	0	Yes	-	3/20/2004	WKD
D	36	Yes	Yes	10323	2.0	789	536	253	0	Yes	-	3/20/2004	WKD
D	36	Yes	Yes	13466	2.6	1029	663	366	0	Yes	-	3/20/2004	JAC
M	37	Yes	Yes	10222	0.0	511	338	173	0	Yes	-	3/20/2004	JAC
D	38	Yes	Yes	10581	1.9	790	520	271	0	Yes	-	3/20/2004	CKM
D	36	Yes	Yes	10615	2.4	858	543	315	0	Yes	-	3/20/2004	CKM
M	36	Yes	Yes	9816	0.0	491	314	177	0	Yes	-	3/20/2004	WKD
D	39	Yes	Yes	17825	2.0	1166	778	389	0	Yes	-	3/20/2004	WKD
D	38	Yes	Yes	9860	0.0	493	312	181	0	Yes	-	3/20/2004	JAC
D	38	Yes	Yes	9117	2.1	737	464	273	0	Yes	-	3/20/2004	JAC
D	38	Yes	Yes	11273	2.1	842	545	297	0	Yes	-	3/20/2004	CKM
M	37	Yes	Yes	10572	2.1	808	517	292	0	Yes	-	3/20/2004	CKM
D	39	Yes	Yes	2681	0.0	134	89	45	0	Yes	-	3/20/2004	WKD
M	38	Yes	Yes	8696	2.0	703	498	205	0	Yes	-	3/20/2004	WKD
D	36	Yes	Yes	15378	3.0	1175	812	364	0	Yes	-	3/20/2004	WKD
D	39	Yes	Yes	9316	1.8	712	465	247	0	Yes	-	3/20/2004	JAC
D	36	Yes	Yes	10022	2.0	766	485	281	0	Yes	-	3/20/2004	CKM
D	35	Yes	Yes	11880	2.3	908	637	271	0	Yes	-	3/20/2004	WKD
D	39	Yes	Yes	10901	2.0	814	573	241	0	Yes	-	3/20/2004	JAC
D	36	Yes	Yes	12967	2.5	991	702	290	0	Yes	-	3/20/2004	JAC
M	37	Yes	Yes	10952	2.1	837	561	276	0	Yes	-	3/20/2004	CKM
D	39	Yes	Yes	9810	1.9	750	501	249	0	Yes	-	3/20/2004	CKM
D	39	Yes	Yes	12946	2.4	967	651	316	0	Yes	-	3/20/2004	WKD
D	37	Yes	Yes	10181	2.0	778	547	232	0	Yes	-	3/20/2004	WKD
D	37	Yes	Yes	10380	2.0	794	531	262	0	Yes	-	3/20/2004	JAC
D	35	Yes	Yes	10629	2.1	813	512	300	0	Yes	-	3/20/2004	CKM
D	39	Yes	Yes	10337	2.0	790	535	256	0	Yes	-	3/20/2004	CKM
D	38	Yes	Yes	10279	2.0	786	539	247	0	Yes	-	3/20/2004	WKD
D	38	Yes	Yes	16761	0.0	838	548	290	0	Yes	-	3/20/2004	JAC

[illegible]

Time Schedules

Sched #	Schedule Name	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Total Hours	Peak Demand	Yes = 1 No = 0	Max Hrs / Yr
	Peak Demand Hours														1	1	1									3			
1	Dormitory Schedule						1	1	1	1										1	1	1	1	1		9	No	0	3285
2	Warehouse									1	1	1	1	1	1	1	1	1	1							10	Yes	1	3650
3	Admin Building							1	1	1	1	1	1	1	1	1	1	1	1							12	Yes	1	4380
4	Hanger	1	1	1	1	1	1	1												1	1	1	1	1	1	13	No	0	4745
5	Garage							1	1	1	1	1	1	1	1	1	1	1	1	1	1					14	Yes	1	5110
6	Stores									1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		15	Yes	1	5475
7	Flight Operations	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	24	Yes	1	8760

Acceptance Report

The acceptance M&V check for the Lighting ECP was performed on 3/20/03. The M&V requires that a USAF selected sample set of fixtures be measured at acceptance. The "LightingEntry" worksheet lists the fixtures that were tested and/or verified during acceptance in columns marked "Post-ECP Acceptance."

All items in the "Accept_Checklist" were completed and two deficiencies were found. All deficiencies have been corrected.

Measurements taken during acceptance were recorded in the appropriate acceptance columns and the cost of the verifications and measurements was recorded in "MeasSpecs" spreadsheet.

The Acceptance Report will contain all tabs (worksheets) in this workbook, updated with current measurements and data.

The following table lists the individuals that performed the acceptance tests:

	Name	Title	Specialty
1	William K. Donaldson	Engineer I	Metering/Surveys
2	Jim A. Carlson	Engineer I	Metering/Surveys
3	Carl K. Matheson	Technician	Metering/Surveys

B. K. Wilson - Manager

Date

Lighting Acceptance Checklist

Documents	Yes	No
Inspect design docs for complete set	X	
Inspect docs for design conditions documentation	X	
All equipment / users manuals in place	X	
Vendor Certifications / Tests		
Construction performed to specs	X	
Performance tests (include results)	X	
All code requirements met	X	
All noise ordinances have been met	X	
Performance Test Standards		
Verify performance tests specification with all parameters specified complete	X	
Overall condition		
Verify the specified equipment is installed per manufacturers specifications	X	
Check color coding and proper labeling on equipment if required by USAF	X	
Performance		
Reference standards for any performance test conditions	X	
Specify all parameters used in performance tests	X	

Accepted – USAF

Date

Certified By – “The ESCO”

Date

Annual Report Year 1

The annual reconciliation for the Lighting ECP required that a USAF selected sample set of light fixtures be inspected on an annual basis. The annual verification, and reconciliation can found in the Post-ECP Reconciliation Year 1 section of the "Lighting" worksheet. After the inspection was conducted, all deficiencies were corrected.

A summary of the predicted savings along with the savings guarantee is listed in the table below. The savings guarantees are also included in the table below. As a result of meeting the guaranteed savings, full payment with no deductions will be made.

The Annual Report will be contain all tabs (worksheets) in this workbook, updated with current measurements and data.

Savings Summary		
Predicted Savings		\$ 100,060
Guaranteed Savings		\$ 95,057
Payment Deductions		\$ -

The following table lists the individuals that performed the annual reconciliation and

	Name	Title	Specialty
1	Jim Johnson	Engineer I	Metering/Surveys
2	Kim D. Anderson	Engineer I	Metering/Surveys
3	Carl K. Matheson	Technician	Metering/Surveys

Accepted – USAF	Date	Certified By – “The ESCO”	Date
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Measurement Specifications and Costs

Measurement					Instrument Used							Comments
Date	Purpose	Cost \$/Each	Type	By*	Accuracy	Type	Mfr	Model	Calibration			
									Type**	Date	By***	
3/20/2003	Acceptance Test	\$10/fixture	Foot-candles	WKD	± 3%	Light Meter	XYZ	401036	Annual	12/21/02	GGL	Calibrated per manufacturer's specifications. Does not include travel.
3/20/2003	Acceptance Test	\$30/fixture	Watts	JAC	± 2%	Power Analyzer	XYZ	380801	Annual	12/21/02	GGL	
3/20/2003	Acceptance Test	\$30/fixture	Watts	CKM	± 2%	Power Analyzer	XYZ	380801	Annual	12/21/02	GGL	

Note: Calibration Standard was included in Phase II Report

* Initials of individual taking the measurements

** Frequency of calibration was included in Phase II Report and is 1 year

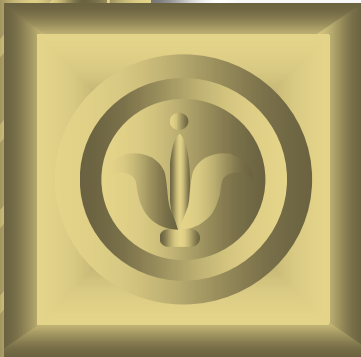
*** Initials of the individual responsible for calibrating the metering equipment.

M&V Contract Deliverables Tracking Form for Year 1 thru Year N

Year	Reports	ESCO Delivery		USAF Acceptance	
		USAF Signature	USAF Date	USAF Signature	USAF Date
	Acceptance				
	Year 1				
	Year 2				
	Year 3				
	Year 4				
	Year 5				
	Year 6				
	Year 7				
	Year 8				
	Year 9				
	Year 10				
	Year 11				
	Year 12				
	Year 13				
	Year 14				
	Year 15				
	Year 16				
	Year 17				
	Year 18				
	Year 19				
	Year 20				
	Year 21				
	Other Contract Specified Deliverables Required after Year 1 thru N				

Lighting Data Column Definitions

Column	Symbol	Definition / Equations				
Yearly Op Hrs	YOH	This column contains the total yearly operating hours for the location and is determined by using the operating schedule worksheet demand table.				
Lighting Diversity Factor	LDF	What portion of the time the lights on.				
Cooling Savings/ Heating Penalty	CSHP	The impact of the lighting on the HVAC using the provided USAF HVAC/Lighting Impact Table, which estimates the impact based on HDDs and CDDs. A copy of this table is below.				
		Heating Degree Days HDD's	Heating Penalty	Cooling Degree Days CDD's	Cooling Savings	Multiply the Net HVAC Impact times the total lighting savings to obtain the additional savings. For example, if HDD = 1400 and CDD = 2200, the net savings multiplier is +5.5%.
		<1000	1%	<1000	2%	
		1000 - 2000	2.50%	1000 - 2000	5%	
		2001 - 3000	4%	2001 - 3000	8%	
		3001 - 4000	5.50%	3001 - 4000	11%	
		4001 - 5000	7%	4001 - 5000	14%	
Light Level (FC)	FC	The lighting level in foot candelas measured in a particular location or the levels required by USAF specified codes.				
Ballast Avail in Stock		The total number of ballast available of a particular type in the building supply room.				
Dmd (kW)	Dmd	The power demand of the light calculated as a function of: Cooling Savings/Heating Penalty, Lighting Diversity Factor, Qty Fixt's (QF), Fixt Cap (W) (FC) columns. $LDF*QF*FC*CSHP/1000 = Dmd$				
Elect Use (kWh)	EU	The total electric used for the year in question as a function of the demand and total operating hours. $YOH*Dmd = EU$				
Cost \$		This is the total cost of running the light for an entire year as a function of a Blended Utility Rate (BUR), the Cost of Electricity (CE), and demand. $EU * CE + BUR * Dmd * 12Months = Cost$				
Savings \$		This is the difference between the pre-ECP cost and the most recent calculated cost.				
Database / Measured		A database of all the fixture types is to be produced. If a fixture is in the database then mark this column as D and use the fixture values found in the database. If a database is not available then measure 10% of the fixtures up to 10 fixtures, append the database with the measured data, and mark the fixtures that were measured as M. Those fixtures of the same type as just measured mark as D using the new information just entered to the database to complete the spreadsheet.				
Savings Amount Over Guarantee (\$)		This column contains those savings found that are above the guaranteed savings, which can now be claimed as savings.				
Reconciliation (\$)		This column contains those savings claimed in the guaranteed savings, which were not found and will be deducted from the total savings.				



M&V Cx Working Group Report

DC - M&V Summit

Steve Dunnivant - Chair

April 2004

Objectives of Working Group

- **Mainstream Use of Commissioning into DOE SuperESPC Projects**
- **Modify IDIQ Contract to address Commissioning Requirements**
- **Expected Completion - 4th Quarter 2004**

Final Deliverable

- **Commissioning content recommendations to be incorporated into revision of IDIQ contracts.**

Current Status

- **Commissioning DO Guidance currently in use on selected projects to identify potential project impacts and improvements**

Accomplishments to Date

- **Adopted Cx Provisions for DO-RFP**
- **Cx Provisions in use for selected projects**
- **Project Management Plan (PMP)**
- **PMP Updated for Agency Witness**
- **Cx Workshop for PF's/ESCO's**
- **Project Mgt. Plan Updated**

Planned Actions

- **Issue Draft ESPC Cx Guidelines – 3rd Qtr FY04**
- **Standardize Cx Report Requirements 3rd Qtr FY04**
- **Training of PF's/ESCO's – 4th Qtr FY04**
- **Provide IDIQ contract input – 4th Qtr FY04**
- **Revise Draft Cx Guidelines for general agency use (generic) – 4th Qtr FY04**

Cx Workgroup Breakout

- **Review Cx Guidance Document**
- **Review of changes to ECM Commissioning Additions**
- **Strategize - Guidance to customers**
- **Review of Status Report Actions**
 - **Cx Report Requirements**
 - **Training**
 - **IDIQ Contract input**
 - **Generic Cx Guide for agency contracts**

CX Working Group

- **Participation!!!**

- ESCO's
- Agency's
- Lab's

- **Thanks for the Support!!!**

M&V Plan and Reporting Integration Working Group Update

Lia Webster
Washington DC M&V Summit
April 22, 2004

Working Group Highlights

Date Formed: January 15, 2004

Meetings To Date: 3

Objective:

- Revise existing outlines for use across Federal sector
 - M&V Plan, Post-Installation Report, and Annual Report outlines
- Ensure consistency, coordination, and uniformity between outlines and in consideration of other work under development (Commissioning and O&M Reporting WG).

Working Group Members

Tony	Robohn	ConEd Solutions
Sylvia	Berry-Lewis	Honeywell International Inc.
Bonnie	Piest	Johnson Controls
Scott	Judson	Noresco
Rick	Rogers	Noresco
Jason	Stone	Noresco
Ron	Araujo	Select Energy Services, Inc.
Jerry	Culbert	Select Energy Services, Inc.
David	Ward	Energy Engineering & Design, Inc.
Michael	Cross	HQ Air Force
Gary	Hein	HQ Air Force
Pat	Mumme	HQ Air Force
Dale	Sartor	Lawrence Berkeley National Laboratory
Max	Hogan	Naval Facility Engineering Service Center
Lia	Webster	Nexant, Inc.
Doug	Dahle	National Renewable Energy Laboratory
Robert	Baugh	Oak Ridge National Laboratory

Background

- The 3 M&V outlines were developed separately over several years:
 - Coordinate content and format between outlines
 - Coordinate content with newer working groups (esp. Commissioning and O&M Reporting)
 - Consider leveraging Annual Report to cover DOE reporting requirements
- Formation of Working Group proposed at the New York City M&V Summit
- WG is many of the same people who originally developed the outlines

Current Status

- Biggest challenges:
 - Coordination with other WGs
 - Keeping outlines contract neutral
- Completed preliminary modifications to Commissioning related items
 - Further discussion with Cx WG planned
- Coordination with O&M Reporting WG planned
- Uniform numbering system for all outlines implemented

Next Steps

WG Deliverable #1: Develop Revised Outlines

- Compare outline formats / organization to ensure consistency to customer and ease of use for ESCOs
- Continue to coordinate with other working group activities
- Annotate outlines to note terminology differences between contracts
- These are 'living documents' which may be modified in the future as needed

WG Deliverable #2: Develop Example Documents

- Modify existing example M&V plan to new format
- Will then consider development of example Post-Install and Annual Reports

Operation and Maintenance (O&M) Working Group Update

Satish Kumar and Lia Webster

Washington DC M&V Summit, April 22, 2004

Working Group Highlights

- **Date Formed:** January 15, 2004
- **Objective:** Develop recommended procedures for documentation and reporting of post- installation Government and ESCO Operations, Maintenance, Repair & Replacement Activities.
- **Current Status:** Prepared a draft Project Documentation Structure
- **Team Members:** Bob Baugh, Mike Cross, Jerry Culbert, Natale Didonato, Randal Duncan, Sam Farouz, Max Hogan, Dave Howard, Dave Hunt, Erik Koehling, Satish Kumar, Will Lintner, Michael Parker, Rick Rogers, Dale Sartor, Bobby Starling, Jason Stone, Kevin Sullivan, Lia Webster, David Williams

Background

- Need for proper O&M reporting and accurate O&M savings determination in all ESPC project:
 - O&M savings estimates have come under increasing scrutiny
 - O&M reporting process should clearly identify parties responsible for different O&M tasks
 - Good O&M reporting will protect both parties in case of disagreements
- Formation of O&M Working Group proposed at the New York City M&V Summit

Current Status

- Researching the concerns of watch dog organizations on O&M savings
- Preparing ECM specific O&M checklists – To be filled out by the responsible party
- Coordinating O&M reporting with other reporting documents (both past and present)

O&M Checklists

- Who is responsible?
- What are the O&M tasks that needs to be performed?
- What is the frequency of the O&M activities?
- What is the process governing the creation, handing out, filling out, and archiving of these checklists?
- What are the technologies/ECMs that are currently covered?

Sample Checklists

- Monthly Preventive Maintenance Sheet For Hot Water System
- Power Plant Maintenance Worksheet

Future Issues

- Plans to develop 6-10 O&M checklists for specific ECMs
 - Looking to ESCOs to provide examples of checklists
- Get input from agency personnel on the checklists
 - Looking to agency reps to circulate the draft checklists to people responsible for O&M of federal facilities; pass back the comments to the WG
- Coordination with other working group activities and reporting outlines
 - Interface with Cx Working Group on the Cx process flow and how and where O&M will fit into it
 - Interface with M&V Plan and Reporting Integration Working Group to include the O&M reporting requirements

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Advanced Metering Working Group

Recommendations on the Application of
Advanced Metering Through
Alternative Financed Energy Contracts

Advanced Metering Working Group

Initial Considerations:

- Advanced metering will probably be unfunded.
- Alternative financing would be an attractive option.
- Advanced metering will assist M&V and performance assurance, and lead to additional projects.
- Guidance should be consistent with proposed Congressional direction e.g. S 2095 and provide a start of required guidance.

Advanced Metering Working Group

Objective Statement:

Identify opportunities and establish guidance to install advanced metering technologies at federal sites, particularly via existing or new alternative financing vehicles.

Advanced Metering Working Group

Definitions needed for consistency

Advanced Meters

- Measure and record interval data, and
- Communicate the data to a remote location

Advanced Metering Working Group

Definitions needed for consistency

Advanced Metering System

- Accept data from one or more meters
- Process energy use data allowing appropriate action

Advanced Metering Working Group

Action Path

- Develop guidelines for advanced metering applications via alternative financing
- Identify installation strategies

Advanced Metering Working Group

Guidelines

- Potential applications
- Types of meters
- Benefits and costs

Advanced Metering Working Group

Potential Application Strategies

- Up-front installation by site request
- As an ECM
 - Project identification tool
 - M&V
 - Load management, demand response purchasing, diagnostic tool (Retro-Commissioning)

Advanced Metering Working Group

Existing Successful Examples

- Resource Efficiency Managers use of advanced meters at Navy's San Diego area installations
- Denver Federal Center
- Fort Bragg

Measurement and Verification of Savings in Combined Heating and Power Projects

John A. Shonder
Oak Ridge National Laboratory

Motivation for this work

- Federal customers interested in combined heating and power for their sites
 - Reduce energy costs
 - Improve reliability of electric supply
- ESPC (including UESC) is often the best (sometimes the only) way to implement these projects given lack of appropriated funds for capital improvements
- M&V required to ensure guaranteed savings are delivered
- Federal customers should be driving development of M&V plan, but often are not
 - Lack of experience/training/interest
 - Sometimes seen as added expense/headache
 - Thus it is often left to Core Teams, PFs and the ESCO to ensure quality of M&V plan

Federal ESPC Task Force has recommended development of M&V templates. Their reasoning:

- *Lack of experience at the installation level: Installation and sometimes HQ may lack expertise or experience in M&V.*
- *General template would simplify the development process and review processes.*
- *A standard template by ECM would simplify the ESCO's response on the M&V process.*
- But CHP is not a single ECM, so a number of standard templates may be required

CHP systems encompass a wide variety of technologies

- Electrical generation
 - Combustion turbine
 - Microturbine
 - Fuel cell
 - Engine/generator
- Thermal end-use
 - Direct use of steam for heating
 - High/low temperature hot water for heating
 - Chilled water production via absorption chiller
 - Desiccant regeneration
 - Process loads
- Rate structure impacts M&V plan as well
- Difficult to specify “one size fits all” M&V plan

FEMP's M&V Guideline v2.2:

- “Measurement and verification plans for cogeneration projects will need to be custom developed by the ESCO and the federal agency since each project is usually unique and there are no guideline M&V methods (as there are for water and energy measures).”

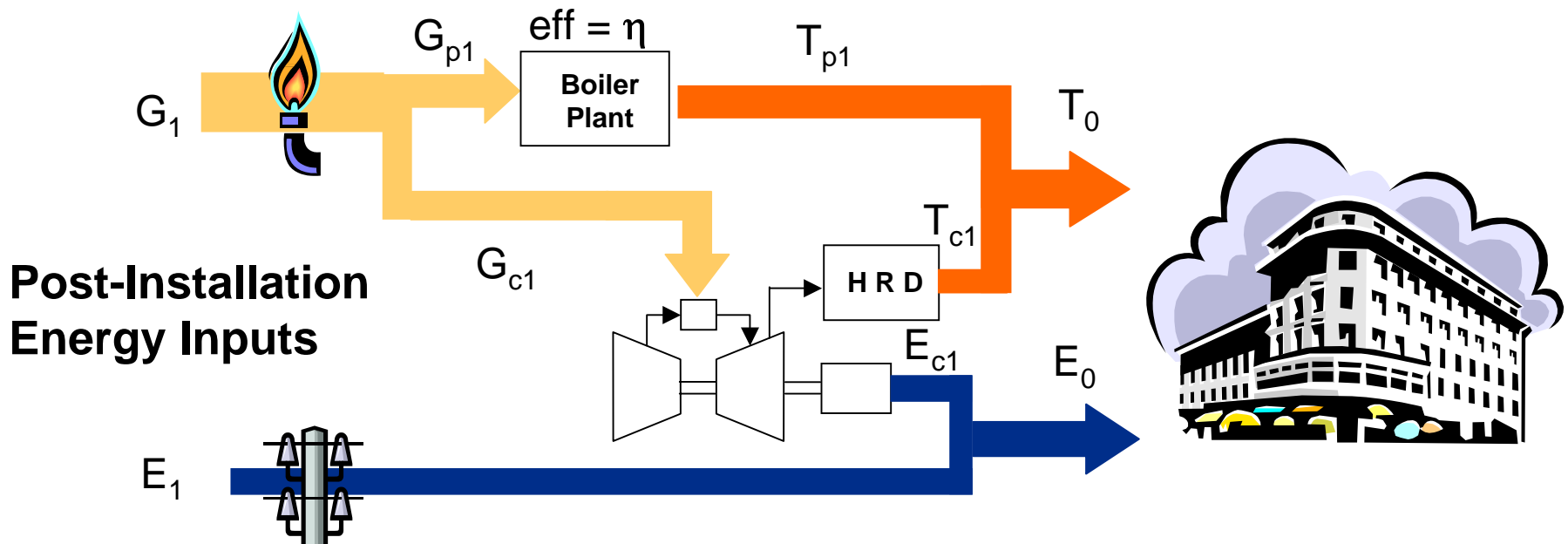
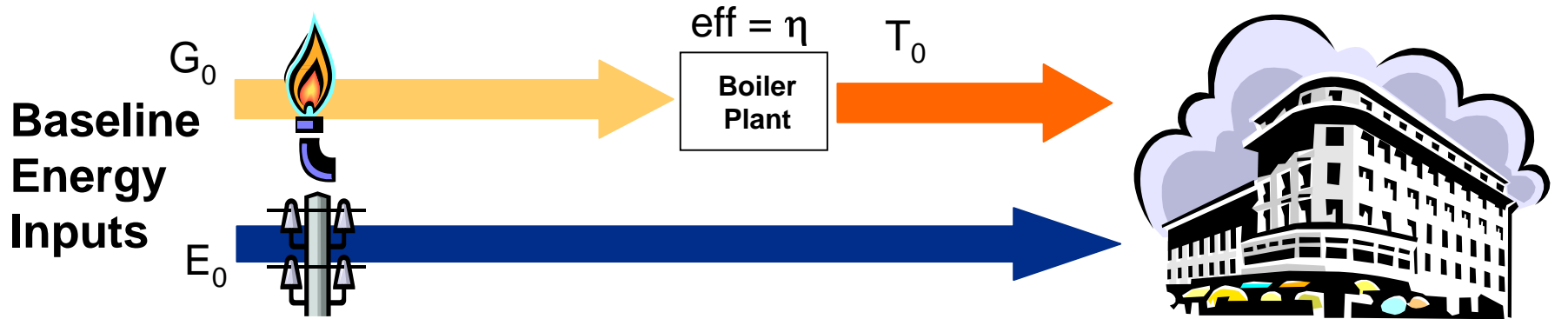
Resources currently available for developing M&V plans for CHP projects

- FEMP M&V Guidelines v2.2, Chapter 34, *Cogeneration Projects*
 - One-for-One Replacement
 - Net Energy Use Analysis
- IPMVP
 - Volume III, “[..] Determining Energy Savings in Renewable Energy Technology Applications”
 - “Developing a M&V Protocol for Distributed Generation Technologies” (11/03 Draft)
- ASHRAE Guideline 14-2003
 - No specific CHP cases, but very useful information

One-for-One Replacement

- Assumes energy produced by the CHP system displaces energy that would have been provided by an existing source
- Energy savings is equal to the economic value of the net energy production by the CHP system
- O&M cost of the CHP system is also a consideration

Determining savings from a simple CHP system: One-for-one replacement



Definition of variables

- **Baseline:**

- G_0 : Natural gas purchased from utility
- E_0 : Electrical energy purchased from utility
- T_0 : Thermal load

- **Post-installation**

- G_1 : Natural gas purchased from utility
- E_1 : Electrical energy purchased from utility
- G_{p1} : Gas used by boiler plant
- G_{c1} : Gas used by turbine
- E_{c1} : Net electrical output from turbine (i.e., after parasitics)
- T_{c1} : Thermal output from CHP system
- T_{p1} : Thermal output from boiler plant

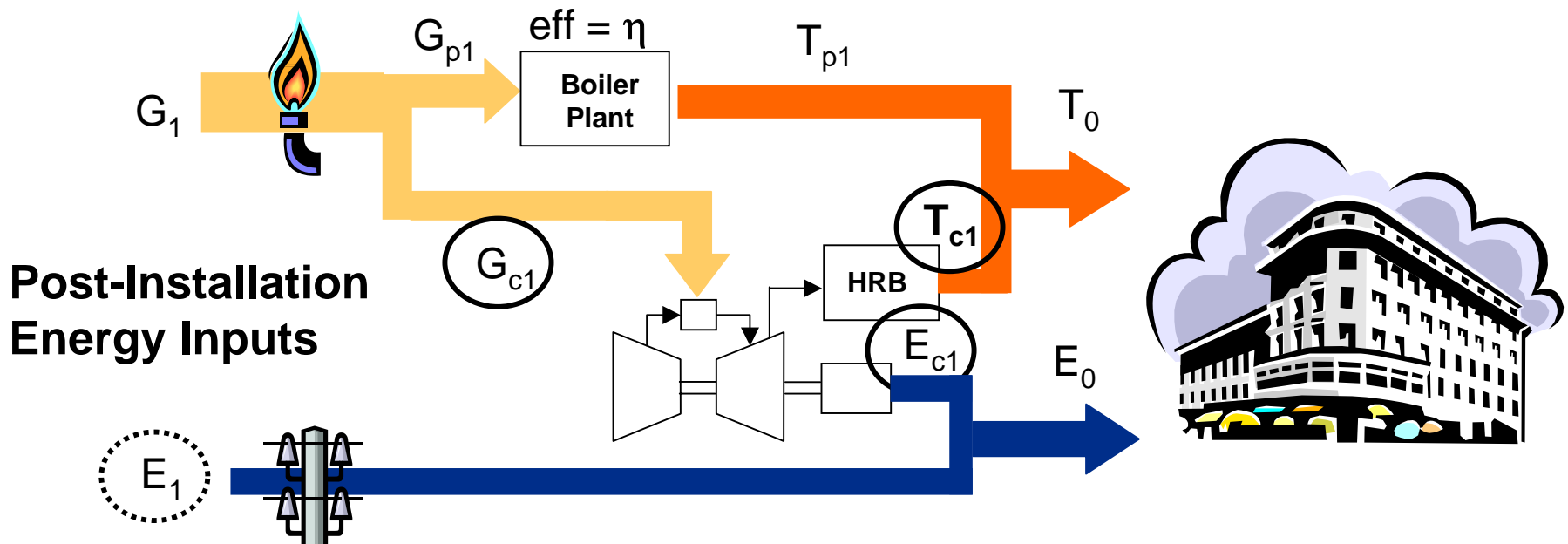
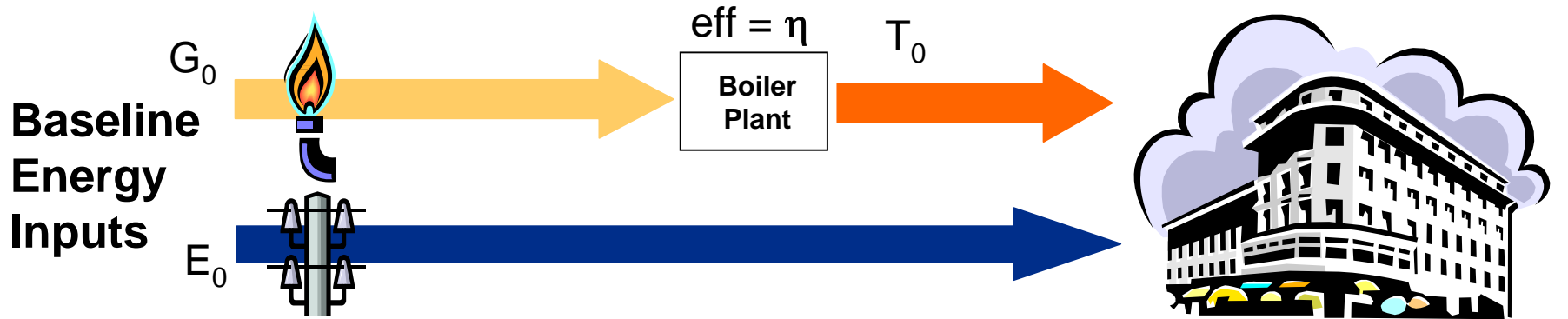
Energy cost savings is baseline cost minus post-installation cost

- Savings = $[\text{Cost}(E_0) + \text{Cost}(G_0)]$
- $[\text{Cost}(E_1) + \text{Cost}(G_1)]$
- In terms of things that can be measured:
Savings = $\text{Cost}(E_{c1}) + \text{Cost}(T_{c1}/\eta) - \text{Cost}(G_{c1})$

$$= \left\{ \begin{array}{c} \text{Value of} \\ \text{generated} \\ \text{electricity} \end{array} \right\} + \left\{ \begin{array}{c} \text{Value of} \\ \text{displaced} \\ \text{natural gas} \end{array} \right\} - \left\{ \begin{array}{c} \text{Cost of} \\ \text{natural gas} \\ \text{used by} \\ \text{CHP} \end{array} \right\}$$

- This simple approach does not consider demand charges, which often drive the economics
- O&M costs are also a factor in project economics as with any ECM

Three measurements are required at a minimum



One-for-One Replacement can be thought of as Option B, Continuous Measurement

- Measure gas input to generator
 - Gas meter totals fuel input to generator
 - Multiply total by per therm cost of natural gas
- Measure electric output from generator
 - Electric meter reads total kWh sent from generator
 - Multiply by electric cost per kWh*
- Measure thermal output from heat recovery boiler
 - Water inlet/outlet temperatures and flow rate
 - $Q = 500 \times \text{gpm} \times \Delta T$
 - Determine how much gas the boiler would have used to produce this amount (Q/η)
 - Multiply by gas cost per therm

Of course, determining the efficiency of the gas boiler may not be easy

- Previous slide assumed that by measuring flow and temperature rise of water through heat recovery device, we could determine how much natural gas the boilers would use to produce same amount of heat
- Efficiency may vary with load (e.g., multiple boilers operating in stages) requiring
 - Modeling/Engineering calculations
 - Stipulation of efficiency if data is lacking

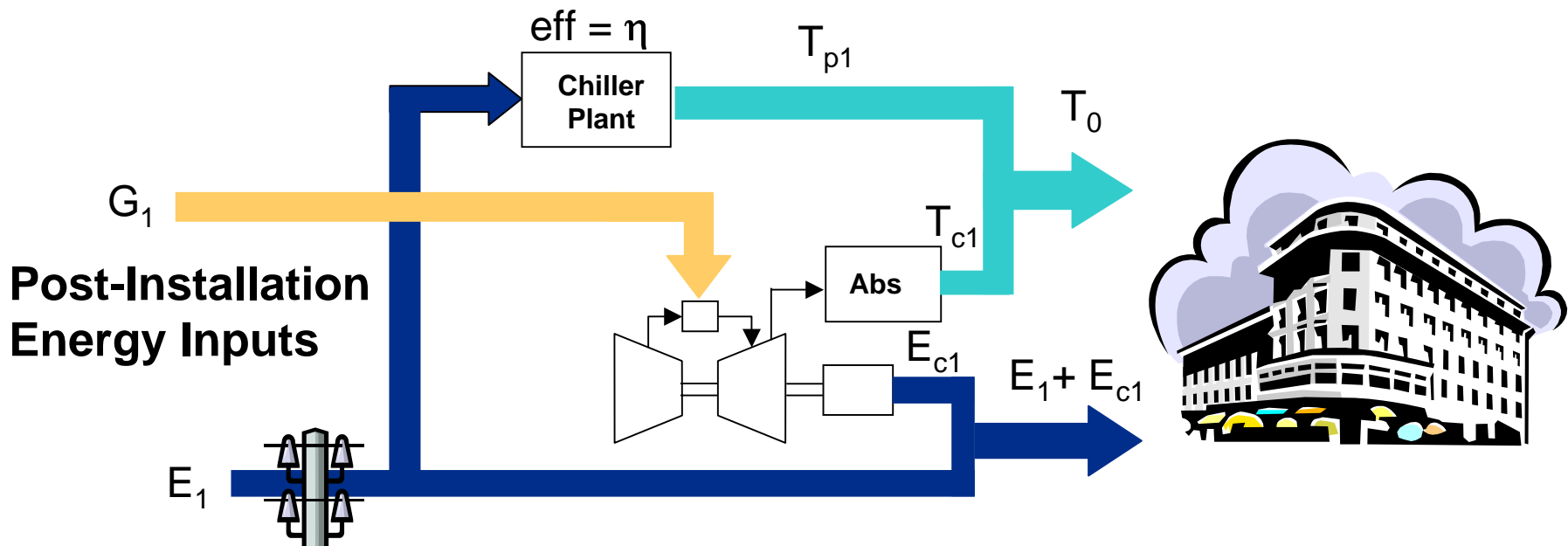
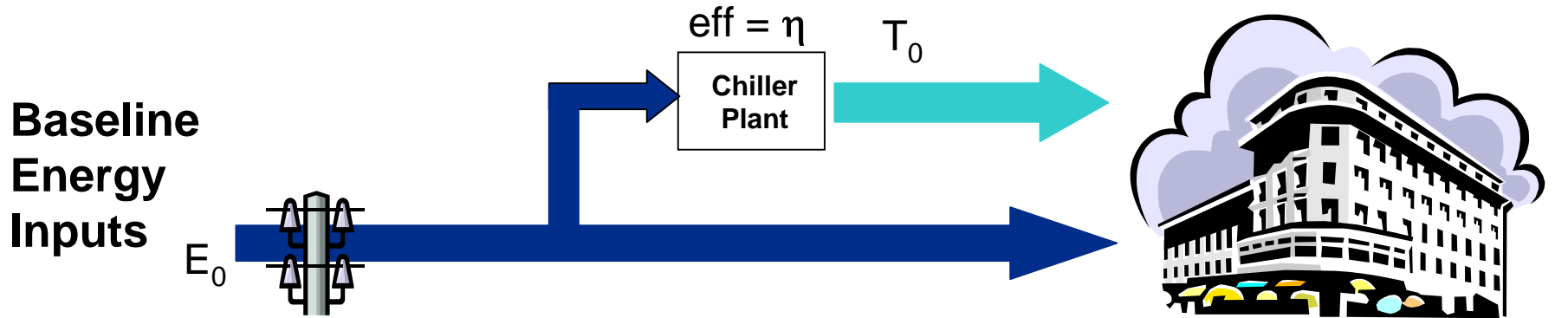
Determining the value of generated electricity E_{c1} may be difficult as well

- Some rate structures include
 - Demand charges with ratchet
 - Block electrical rates
 - Time of day rates
- Electrical production from CHP cannot be priced in isolation
- One possibility is to price the total electrical load
- This amounts to reconstructing what the utility bill would have been in the absence of CHP

Pricing the total electrical load

- Record E_{c1} and E_1 at 15-minute-intervals
- Add E_{c1} and E_1 to determine total facility electrical demand
- Use applicable rate structure to determine cost if all electrical energy had been delivered by utility
- Value of E_{c1} is hypothetical utility bill minus actual utility bill
- Note that this incorporates all standby charges, interconnect fees, rate renegotiations

Waste heat may also be used to displace electrical energy



Here it is more difficult to determine the economic value of the displaced energy

- Savings = $[\text{Cost}(E_0) + \text{Cost}(G_0)]$
- $[\text{Cost}(E_1) + \text{Cost}(G_1)]$
= $\text{Cost}(E_{c1}) + \text{Cost}(T_{c1}/\eta) - \text{Cost}(G_{c1})$
- kW/ton (η) of electric chiller depends on outdoor air temperature and load, so efficiency changes minute-by-minute
- The more complicated the calculations, the less confidence one has in them
- Other approaches may be warranted

One option is to stipulate this portion of the savings

- Use engineering calculations to estimate displaced electrical load due to reduced chiller load as a function of chilled water production and outdoor air temperature
- Stipulate an annual value based on typical year conditions; calculate annually based on actual conditions and compare
- Can also use Net Energy Analysis

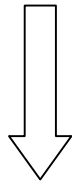
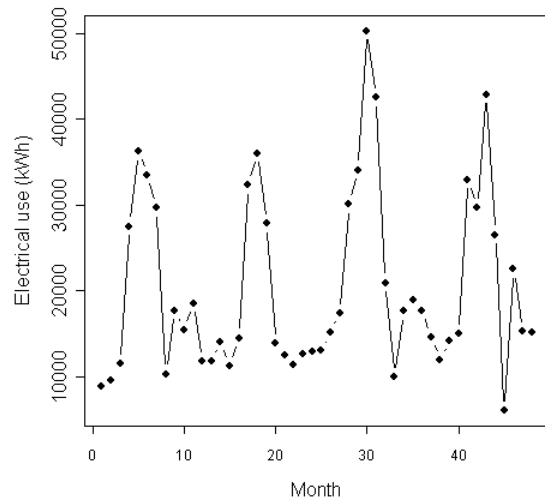
Net Energy Use Analysis: Similar to Option C

- Develop a model of baseline energy use
 - Relate electrical energy and gas use to weather and other variables
- Post-installation:
 - Use baseline formula to determine energy that would have been consumed during the period
 - Subtract actual energy use to determine savings
- As always, $\text{Savings} = [\text{Cost}(E_0) + \text{Cost}(G_0)] - [\text{Cost}(E_1) + \text{Cost}(G_1)]$ but here we estimate E_0 and G_0

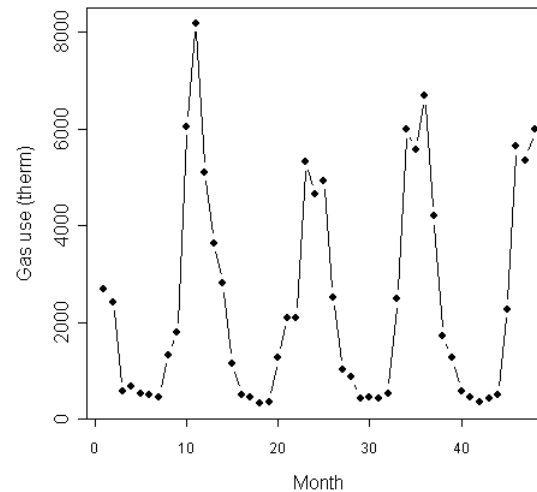
Example system

- Small residential area consisting of 40 homes
- Air conditioning with central air units
- Heating with gas furnaces
- Gas water heaters
- Four years of data available

Step 1: Correlate baseline gas and electric use to heating/cooling degree-days and days per billing period



$$E_0 = (325.8 + 3.49n) \times \text{ndays} + 133.0 \times \text{CDD}_{71} + 3.23 \times \text{HDD}_{64}$$

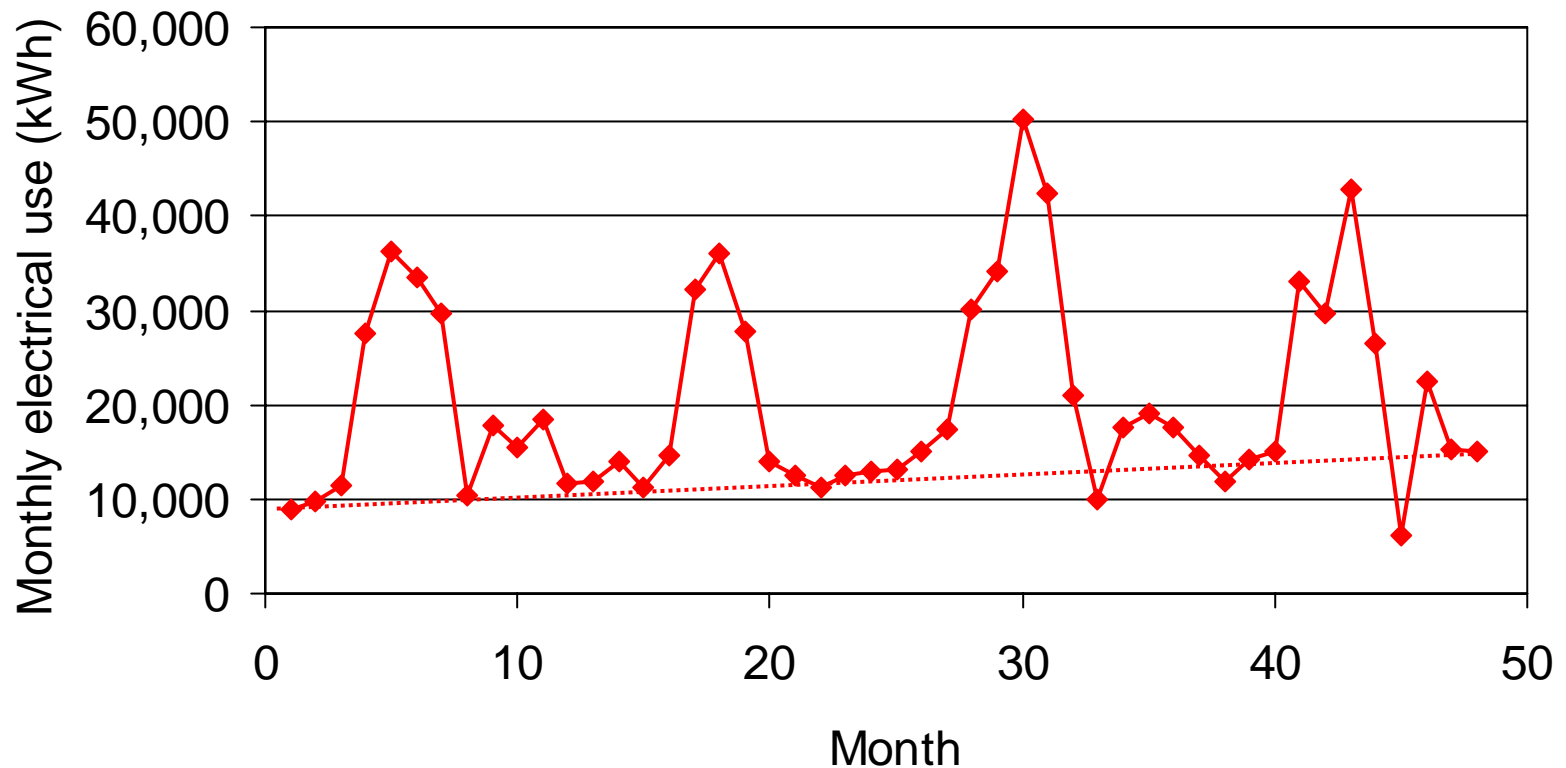


$$G_0 = 14.48 \times \text{ndays} + 7.04 \times \text{HDD}_{64}$$

These are not simple regressions

- Note that the models depend on:
 - Number of days in billing period
 - CDD and HDD to base temperatures determined from the data (not pre-determined)
- Development of models like these requires specialized software (Excel generally won't do)
- Variable-base degree day calculations require access to daily average temperature data
- Consult ASHRAE Guideline 14-2002 Annex D, "Regression Techniques"

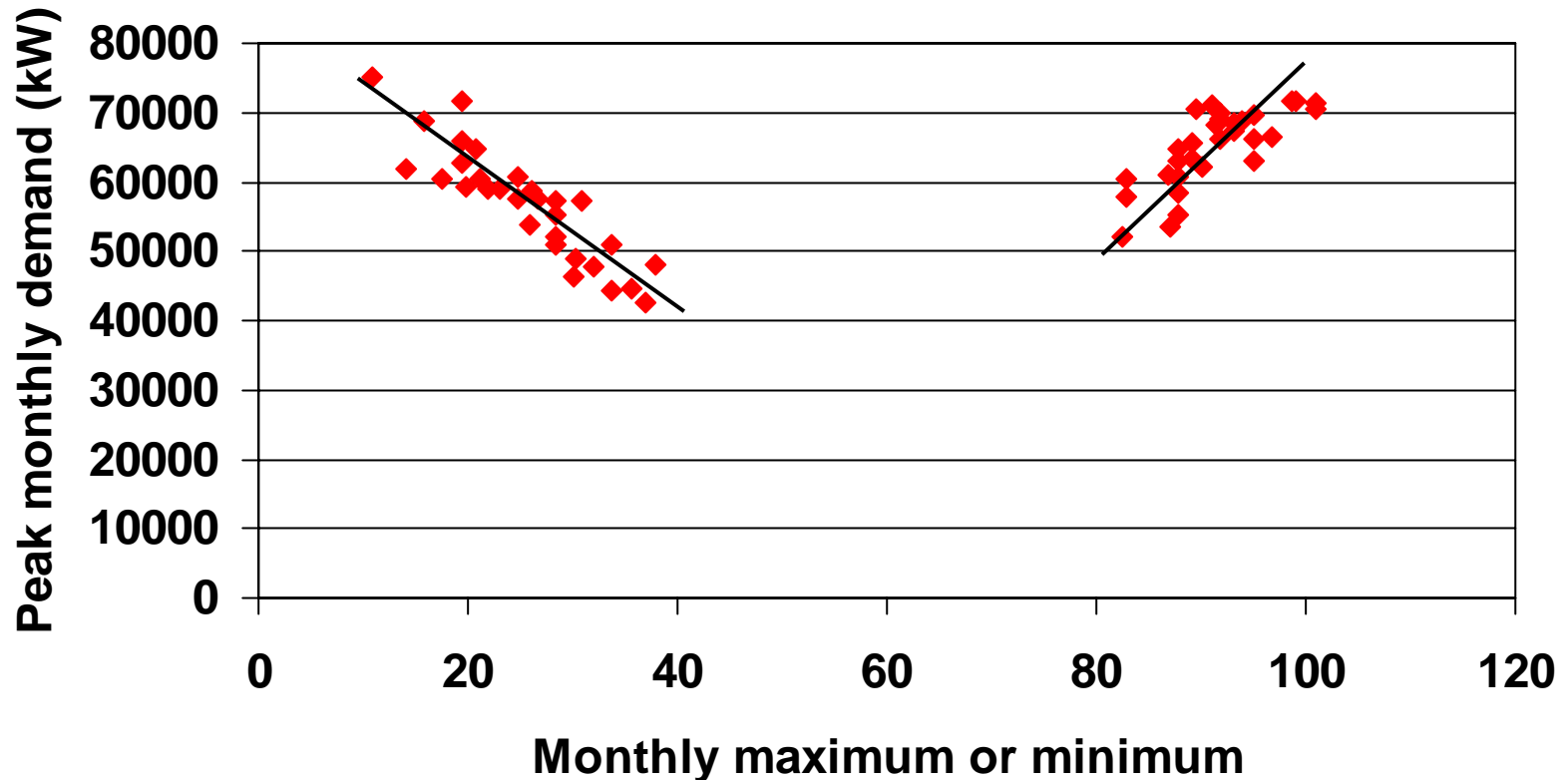
In the case of electrical use, model must account for “load creep” or savings would quickly disappear



For electrical use, a demand model will likely also be required

- Some energy cost savings are due to a reduction in demand charges
- For an M&V plan like this, we must predict what demand would have been in the absence of the CHP system
- This can be difficult to do
- Peak demand is generally coincident with extreme outdoor temperatures, but not always so

Always look at the data: predicting peak demand may not be as difficult as you think



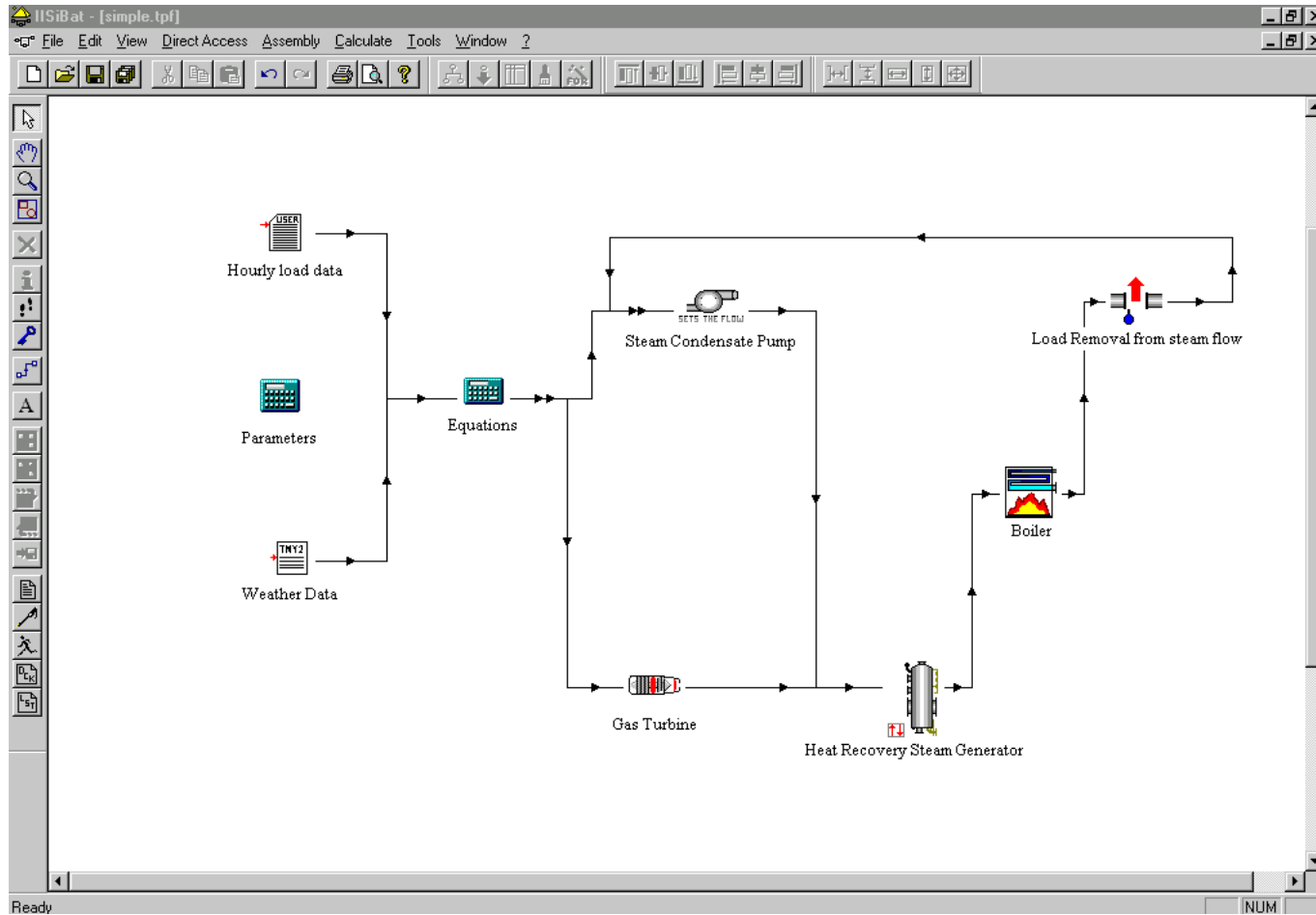
Then, every time utility bills are received do the following:

- Record billed kWh and therms
- Determine number of days in billing period
- Calculate HDD and CDD to proper base temperatures for the billing period
- Calculate baseline gas and electric use from correlations
- Use appropriate rates to determine cost of baseline gas and electric use
- Subtract billed gas and electric to determine energy cost savings
- M&V report shows that savings calculated this way are greater than or equal to guaranteed savings

Option D (Calibrated Simulation) M&V can also be applied to CHP projects

- In some situations, neither “one-for-one replacement” nor “net energy analysis” methods provide reliable results
 - Difficult to determine cost of displaced energy (as in previous example)
 - Available utility data not applicable (construction or demolition of buildings, for example)
- Simulation models may be used to estimate energy and energy cost savings

Example TRNSYS Simulation



Developing an Option D M&V plan

- Develop baseline simulation model
- Calibrate to site-monitored data (install temporary equipment if necessary)
- Finalize baseline fuel and electrical use model
- Implement CHP equipment in software
- Predict post-installation fuel and electrical use
- Annually, show that CHP system continues to operate per assumptions in post-retrofit model

Conclusions

- Purpose of M&V for a CHP project is to show that energy cost savings are consistent with guarantees
- CHP systems have the advantage that they actually produce energy, and this energy production can be measured
- If the economic value of the energy produced by the CHP system can be easily determined, then M&V is relatively straightforward
 - Calculate the value of the net energy produced
 - Show that it is consistent with guaranteed savings

Conclusions

- If economic value can not be determined directly, modeling may be necessary
 - Develop baseline fuel and electrical use model based on historical utility bills
 - Subtract actual billed usage from usage predicted by baseline models
 - Show that energy cost savings is consistent with guarantees
- Calibrated simulations can also be used to verify savings guarantees

Where do we go from here?

- Examination of available M&V plans for CHP projects shows that more work is needed in this area
- Some current plans do not provide sufficient verification that guaranteed savings are being achieved
- What is needed are straightforward methods that compare what energy costs “would have been” in the absence of CHP with what costs actually are
- That is the only definition of savings that makes sense, and it should be the driving factor in M&V for CHP

M&V Strategies for a Cogen Plant at the GSA White Oak



Presented at the
Federal M&V Summit
Washington D.C

April 22, 2004
By
Mustafa Abbas



M&V Strategies for a Cogen Plant

PHASE 1 & 2

- Located at Silver Spring, MD
- Approx. Cost: \$25M (Cogen Plant and Distribution)
- Approx. Annual Savings: \$1.04M in Energy
\$1.8M in O&M
- Building-Side Savings: \$0.4M
- Over 20 Years: >\$100M in Total Savings



M&V Strategies for a Cogen Plant

Energy Conservation Measures (ECM)

- Photovoltaic System
- Phase 1 & 2 Cogeneration Plant
- Hydronic Distribution
- Site Electrical Distribution
- Lighting Upgrades
- Glazing Upgrades
- AHU Redesign
- ChW Pump VFDs
- HW Pump VFDs
- Economizer
- Demand Control Ventilation
- Night Setback



M&V Strategies for a Cogen Plant

COGEN PLANT (Phase 1&2)

- Wartsile Engine: 6MW
- Standby Diesel: 2MW
- Absorption Chiller: 1 @ 1,130 Tons
- Electric Chiller: 2 @ 1,980 Tons
- Hot Water Boiler: 3 @ 10,000 MBtu/h
- Heat Recovery Boiler: 1 @ 20,000 MBtu/h



M&V Strategies for a Cogen Plant

BASELINE

Based On;

- 35% Design Drawing for Office Building
- 100% Design Drawing for Laboratory
- 50% Design Drawing for Central Plant



M&V Strategies for a Cogen Plant

PLANT BASELINE

- No Cogen
- 25kW Photovoltaic Array
- 3 - 1,130 Ton Electric Chillers
- 3 - CV 100hp CHWPs
- 3 - CV 125hp CWPs
- 3 - CV 100hp CT Fans
- 12°F CHW DT; 12°F CW DT



M&V Strategies for a Cogen Plant

EXISTING PLANT (Phase 1 & 2)

- 6 - MW Cogen + 2MW Backup
- 28kW Photovoltaic Array
- 1 - 1,130 Ton Lead Absorption Chiller
- 2 - 1,980 Ton Electric Chillers
- 1 - 250hp CHWP with VFD
- 3 - 150hp CWPs with VFD
- 3 - 75hp CT Fans with VFD
- 20°F CHW DT; 17°F CW DT



M&V Strategies for a Cogen Plant

M&V APPROACH

1. M&V for Chillers
2. M&V For Engine



M&V Strategies for a Cogen Plant

M&V For Chillers

Point

Engineering Units

Interval

Chiller Command	On/Off	15 min.
Absorption Chiller H/W consmp.	GPM	15 min.
Absorption Chiller H/W Supply Temp.	°F	15 min.
Absorption Chiller H/W Return Temp.	°F	15 min.
Chiller Power	kW	15 min.
Chiller Flow (Electrical Chiller)	GPM	15 min.
Chiller Flow (Absorption Chiller)	GPM	15 min.
Chilled Water Supply Temp.	°F	15 min.
Chilled Water Return Temp.	°F	15 min.



M&V Strategies for a Cogen Plant

M&V For Chillers

- Calculate kW/Ton for Electric Chillers

$$\text{kW/Ton} = (\text{Chiller kW} \times (12,000)) / (500 \times \text{GPM} \times \Delta T).$$

- Calculate COP for Absorption Chiller

$$\text{COP} = [500 \times \text{HW GPM} \times \Delta T] / (500 \times \text{CHW GPM} \times \Delta T)$$



M&V Strategies for a Cogen Plant

M&V For Chillers

1. Campus Thermal Load as Agreed-to From Simulation
2. Compare kW/Ton Profiles of Actual Performance vs Manufacturer's Specs.
3. A) If within agreed-to band, then Savings as Calculated
B) If $>$ band, then Savings Recalculated by substituting Actual Performance Profile with Agreed-to Load profile



M&V Strategies for a Cogen Plant

M&V For Cogen Engine

Point

Engineering Units

Interval

Generated electricity

kWh

15 min.

N. G. consumption
by the engines

MMBtu

15 min. .



M&V Strategies for a Cogen Plant

M&V For Cogen Engine

- Calculate Heat Rate for the Engine
- Heat rate (Btu/kWh) is an indication of the performance of the engines. It is the ratio of the heat added to the cycle in Btu/h (LHV), to generation, in kWh
- Heat Rate = Gas Consumption [Btu(LHV)] / [(kWh Output at the shaft).



M&V Strategies for a Cogen Plant

M&V For Cogen Engine

1. Campus kW Load as Agreed-to From Simulation
2. Compare Heat Rate Profiles of Actual Performance vs Manufacturer's Specs.
3. A) If within agreed-to band, then Savings as Calculated
B) If $>$ band, then Savings Recalculated by substituting Actual Performance Profile with Agreed-to Load profile

M&V Strategies for a Cogen Plant

BASELINE MODELING

Days	Hour	OADB (deg F)	Average Electric (kW)	Average Heating (btuh)	Average Cooling (ton)
			a = TRACE data	b = TRACE data	c = TRACE data
31	1	31	1457	15,264,900	250
	2	29	1457	15,771,443	237
	3	28	1457	16,225,414	222

M&V Strategies for a Cogen Plant

BASELINE MODELING

Electricity from Grid (kW)	Chiller Operation				Boiler Operation (btuh)
$d = a + g + h + i$	Chiller #4 (ton-hr)	Chiller #3 (ton-hr)	Chiller #2 (ton-hr)	Chiller #1 (ton-hr)	$f = b * (1 + \%DA \text{ steam}) + \text{loss}$
1831	273	0	0	0	17,070,690
1819	260	0	0	0	17,629,861
1806	245	0	0	0	18,130,998

M&V Strategies for a Cogen Plant

BASELINE MODELING

	kW	total kWh	On-pk	Mid-pk	Off-pk	on-pk all kwh	on-pk \$/kW	Mid-pk \$/kW	off	\$/KW	Elec \$	Boiler Fuel Consumption (mmBTU)	Fuel \$
Jan	4,217	1,833,527	741,909	627,722	463,896	0.02375	0.03265	0.02708	0.01438	4.069	\$108,872	17,850	\$71,399
Feb	4,204	1,656,455	669,329	567,259	419,867	0.02375	0.03265	0.02708	0.01438	4.069	\$99,974	16,406	\$65,626

M&V Strategies for a Cogen Plant

POST MODELING

Days	Hour	OADB (deg F)	Facility Electric (kW)	Heating w/ Pipe Losses (btuh)	Cooling w/ Pipe Losses (ton-hr)
			a = from TRACE runs	b = y + max(col. y)*1%	c = z + max(z) * 1%
31	1	31	1788	3,664,477	16
	2	29	1788	3,889,363	16
	3	28	1789	4,088,749	16

M&V Strategies for a Cogen Plant

POST MODELING

Total Electric Need (kW)	No. of Engines Required	Engine Load (%)	Net Elec output (kW)	Grid Electricity (kW)
$d = a + o + p + q$	$e = \text{roundup}(d/\text{engine capacity})$	$f = d / (e * \text{engine capacity})$	$g = \min(d, \text{total \# of engines installed} * \text{engine capacity})$	$h = d - g$
2,015	1	34%	2,015	0
2,014	1	34%	2,014	0
2,013	1	34%	2,013	0

M&V Strategies for a Cogen Plant

POST MODELING

Fuel (HHV) input kbtu/hr	HR Boiler From Exhaust (kBTUh)	HT jacket (kBTUh)	LO jacket (kBTUh)	LT jacket (kBTUh)
$i = f * \text{slope1} + \text{constant1}$ (from "Engine Performance" sheet)	$j = f * \text{slope2} + \text{constant2}$ (from "HRSG Performance" sheet)	$k = f * \text{slope3} + \text{constant3}$ (from "Engine Performance" sheet)	$k1 = f * \text{slope4} + \text{constant1}$ (from "Engine Performance" sheet)	$k2 = f * \text{slope5} + \text{constant1}$ (from "Engine Performance" sheet)
21,447	3,544	4,401	1,570	1,338
21,441	3,544	4,401	1,570	1,338
21,436	3,543	4,400	1,570	1,338

M&V Strategies for a Cogen Plant

POST MODELING

Boiler Operation (BTUh)	Boiler Natural Gas (mmBTUh)	(n4) Chiller #4 (ton- hr)	(n3) Chiller #3 (ton-hr)
$I = b - j*1000 - k*1000 - k1*1000$	$m = I/10^6/\text{boiler eff}$	n4	n3
0	0	16	0
0	0	16	0
0	0	16	0

M&V Strategies for a Cogen Plant

POST MODELING

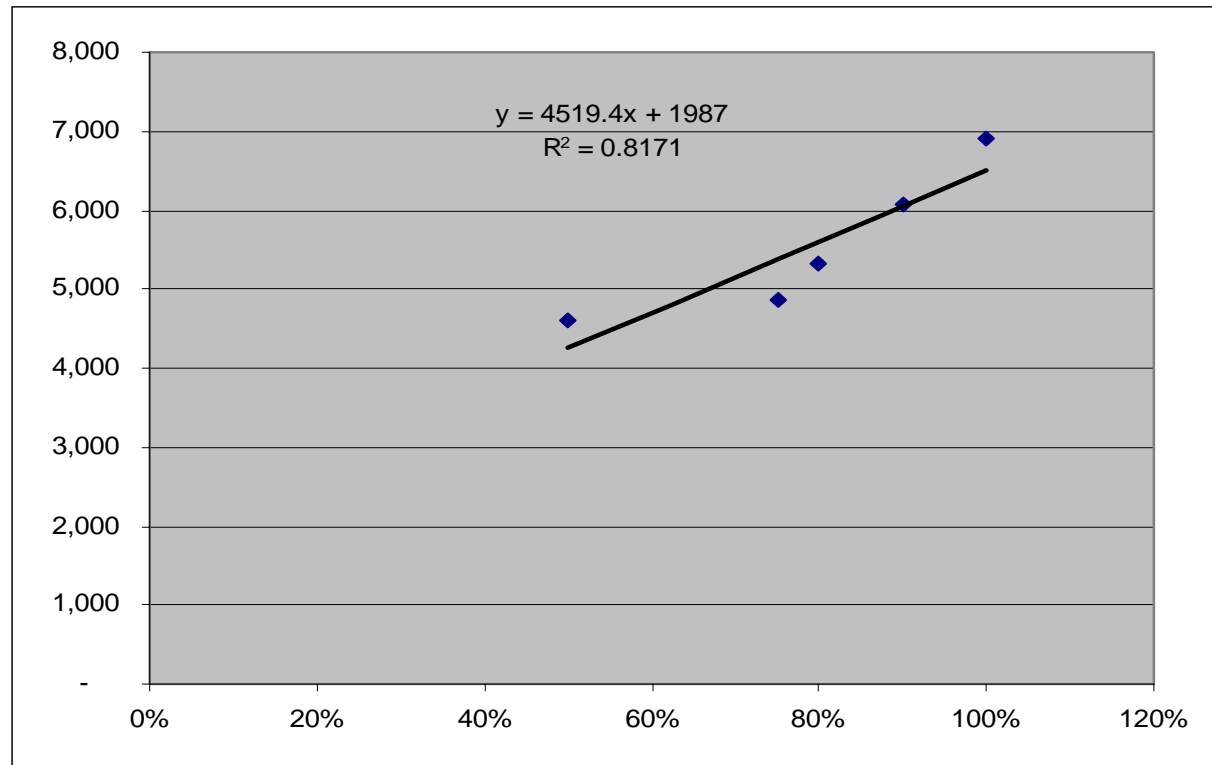
Month	Days/month	Peak Demand	On-Peak Daily Consumption	On-Peak Daily Consumption	Mid-Peak Daily Consumption	Off-Peak Daily Consumption	Total Daily Consumption
		(kW)	(kWh)	(kWh)	(kWh)	(kWh)	(kWh)
Jan	31	0	0	0	0	0	0
Feb	28	0	0	0	0	0	0
Mar	31	0	0	0	0	0	0

Monthly Peak Demand	Monthly On-Peak Consumption	Monthly Mid-Peak Consumption	Monthly Off-Peak Consumption	Total Monthly Consumption	Daily Fuel Consumption	Monthly Fuel Consumption
(kW)	(kWh)	(kWh)	(kWh)	(kWh)	(mmBTU)	(mmBTU)
0	0	0	0	0	677	20,979
0	0	0	0	0	685	19,174
0	0	0	0	0	651	20,181

M&V Strategies for a Cogen Plant

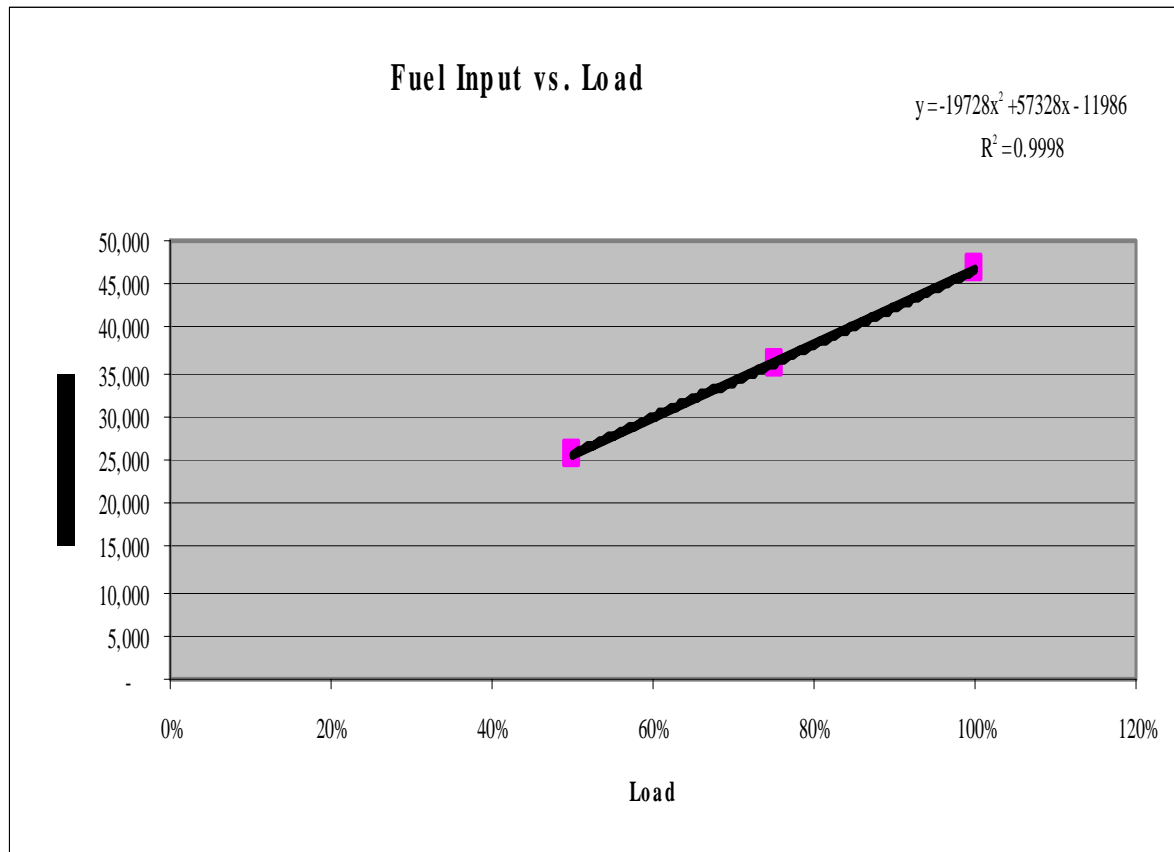
POST MODELING

Load	Steam Production
50%	4,613
75%	4,856
80%	5,323
90%	6,082
100%	6,913



M&V Strategies for a Cogen Plant

POST MODELING





M&V Strategies for a Cogen Plant

CONCLUSION

- Plant and the Buildings did not exist
- Base loads are simulated based on designs drawings
- Post loads are simulated based on value engineering modifications to the original design
- Savings are based on efficiency guarantee – not on loads
 - SES does not have control over buildings loads
 - SES has control over how system performs

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April 21st – 23rd, 2004, Washington, D.C.

Effective Measurement & Verification of Savings with little to no Metering

Bonnie Piest
Project Development Engineer
Johnson Controls, Inc.

Venkat Kumar
Solution Design Manager
Johnson Controls, Inc.

Effective M&V of Savings with little to no Metering

- Project Summary
- ECM Summary
- Summary of M&V Activities & Savings Analysis – By ECM
- Summary of M&V Results for Years 1 through 4
- Critical Success Factors

Effective M&V of Savings with little to no Metering

Project Summary

- Project Investment of \$4.43 million
- Contract Term of 19 yrs, ECMs Simple Payback of 8.5 yrs
- Year 1 Estimated Annual Savings of \$528,724
 - Year 1 energy savings of \$208, 774
 - Year 1 O&M savings of \$319,950
- Term Guaranteed Savings of \$12,739,694
- Performance Period Services include Operation Oversight, Maintenance Oversight, M & V
- Customer Required Flexibility to make mission changes, building additions, modifications, etc.

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ECM	Title	ECM Summary	M&V Methodology
1.1	Replace Boilers with New Steam Production System	Remove existing high pressure water tube boilers and replace with oil thermal transfer steam generation system	Generic Variable Load (GVL-B-01)
3.1	EMCS, Controls Upgrade & Life Safety Supervisory System	Extend EMCS to provide operating room served by AHU-6 of Building 200 with automated data gathering and energy reductions, recondition dampers, and replace base fire alarm system & integrate w/ EMCS	Constant Load Motors (CLM-A-01), Generic Variable Load (GVL-C-02)
3.2	Replace Medical Air Compressor	Remove three existing 25-hp air compressors and replace with two new 40-hp rotary air compressors	Generic Variable Load (GVL-B-01)
4.1	Replace Cooling Coils	Replace cooling coils in air-handling system AC2 and AC3 of Building 203 due to loss of heat transfer performance and excessive pressure drop resulting from corrosive material buildup on coils.	Constant Load Motors (CLM-A-01)
5.1	Lighting Retrofit	Remove and recycle existing lamps and ballasts. Install new high-efficiency lamps and electronic ballasts. Retrofit or replace existing fixtures with higher efficiency fixtures and install lighting controls	Lighting Efficiency (LE-A-02), Lighting Controls (LC-A-01)
8.1	Motor Efficiency Upgrade	Replace all existing electric motors with high-efficiency motors where payback is 9 yrs or less.	Constant Load Motors (CLM-B-01)

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Summary of M&V Activities and Savings Analysis – ECM 1.1

ECM 1.1: Replace Boilers w/ New Steam Production System – M&V Activities

- Instantaneous input kW measurements while equipment is operating at the system design temperature and pressure:
 - Four 40-hp transfer oil pump electric motors
 - Four 15-hp combustion air blower fan motors
 - Four 3/4-hp heat recovery circulating pump motors
- Run time of Oil Circulating pumps through Metasys
- Record Steam Production
- Record Natural Gas Consumption

ECM 1.1: Replace Boilers w/ New Steam Production System – Analysis

- Calculate kWh post-retrofit consumption, calculate post-retrofit boiler plant efficiency
- Compare with validated & agreed-to baseline information to determine savings

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Summary of M&V Activities and Savings Analysis – ECM 3.1

ECM 3.1: EMCS Upgrade & Life Safety Supervisory System – M&V Activities

- EMCS Annual Evaluation and Checkout of Calibration, Programming, Strategies
- AHU-6 & EF-5 Building 200 / Operating Room Controls – Verification of AHU motor occupied & unoccupied schedule, frequencies of VFD, kW of VFD
- AHU-1, Building 210 - Verification of AHU motor occupied and unoccupied schedule, frequencies of VFD, kW of VFD
- Damper Reconditioning – Verification of damper position schedule and damper actuation (once a day) to minimize “sticking “ due to corrosion
- Base Loop Fire Alarm System – No annual verification activities

ECM 3.1: EMCS Upgrade & Life Safety Supervisory System – Analysis

- Calculate kWh post-retrofit consumption, where applicable
- Compare with validated and agreed-to baseline information to determine savings

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Summary of M&V Activities and Savings Analysis – ECM 3.2

ECM 3.2: Replace Medical Air Compressors – M&V Activities

- Annual high pressure air-flow test to determine air delivery rate of the compressors using a (Aerometrix) compressed air-flow meter
- Annual compressor motor kW measurements during the air-flow test
- Verification of compressor operating hours using unit mounted microprocessor

ECM 3.2: Replace Medical Air Compressors – Analysis

- Correct measured air-flow rate to account for temperature
- Calculate annual kWh consumption for compressors using measurements
- Calculate air-delivery rate per kWh
- Calculate compressor efficiency savings by prorating baseline compressor kWh consumption with improved air delivery rate
- Compare with validated and agreed-to baseline information to determine savings

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Summary of M&V Activities and Savings Analysis – ECM 4.1

ECM 4.1: Replace Cooling Coils – M&V Activities

- Measurement of instantaneous input kW on AC-2 and AC-3 using handheld power meter
- Annual (pitot-tube duct traverse) air-flow measurements on AC-2 and AC-3
- Differential static pressure across cooling coils AC-2 and AC-3 continuously monitored.
- Field verification of differential static pressure w/digital hand held manometer

ECM 4.1: Replace Cooling Coils – Analysis

- Calculate motor bhp using measured airflow and measured static pressure drop
- Calculate electricity consumption using stipulated operating hours
- Compare with validated and agreed-to baseline information to determine savings

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Summary of M&V Activities and Savings Analysis – ECM 5.1

ECM 5.1: Lighting Retrofit – M&V Activities

- Measurement of instantaneous input kW on sample of retrofit fixtures using handheld power meter
- Measurements taken with participation of customer personnel
- Installed lighting equipment and occupancy sensors inspected
- Small quantities of burnt out lamps noticed and identified to customer

ECM 5.1: Lighting Retrofit – Analysis

- Extrapolate Sample measurements to total fixture population of scope
- Calculate electricity consumption using stipulated operating hours
- Compare with validated and agreed-to baseline information to determine savings

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Summary of M&V Activities and Savings Analysis – ECM 8.1

ECM 8.1: Motor Efficiency Upgrade – M&V Activities

- Measurement of instantaneous input kW on all motors using handheld power meter
- Measurements taken with participation of customer personnel
- Motors operating at reduced speeds due to VFDs and changed baseline conditions identified

ECM 8.1: Motor Efficiency Upgrade – Analysis

- Calculate electricity consumption using stipulated operating hours
- Compare with validated and agreed-to baseline information to determine savings

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Summary of M&V Results for Years 1 through 4

Project Energy Savings to Date

Yr End of Jan 31	kWh per year	Therms per year	Equiv. mmbtu / yr
2001	2,291,651	98,966	17,720.28
2002	2,244,695	136,932	21,356.58
2003	2,329,127	139,603	21,911.96
2004	2,327,795	136,033	21,550.41
Total	9,193,268	511,534	82,539.24

Project Cost Savings to Date

Year End of Jan 31	Proposed Estimated Cost Savings	Guaranteed Cost Savings	Actual Cost Savings
2001	\$528,724	\$507,575	\$517,973
2002	\$544,586	\$522,802	\$544,987
2003	\$560,924	\$538,486	\$568,684
2004	\$577,751	\$554,641	\$584,160
Total	\$2,211,985	\$2,123,504	\$2,215,804

Proprietary Information - JCI

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Critical Success Factors -

- Simplification of Contract M&V and Service Activities such that it is understood clearly by customer facilities personnel
- Good communication between JCI Performance Assurance Specialist (PAS), Customer and JCI Service Team, e.g. the use of calendar of proposed service activities
- Frequent Visits to maintain interaction with customer and be aware of ongoing changes to facilities, improvements, etc.
- Calibration of Measurement Equipment Used